Strategic Information Systems Planning And Information Technology Roadmapping: Case Study Of A Small Primary Forest Products Manufacturer In Northern British Columbia

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ABSTRACT

The purpose of this paper was to analyze the strategic information technology requirements (IT) of Gateway Forest Products (GFP) and to provide a plan outlining what, when, and how various ITs should be implemented.

Literature related to the use of IT in the forest products industry (FPI) was reviewed to provide the background knowledge required to support a strategic information systems planning (SISP) process for the benefit of a small forest products company based in Northern British Columbia. GFP is selected as the target company of this case study.

ITs were identified that could benefit GFP. A methodology for systematically identifying IT needs was necessary to select potential IT implementation projects. Various strategic information system planning frameworks are reviewed and the Fast-Start technology roadmapping process was selected for soliciting and developing high level information requirements of GFP.

The Fast-Start technology roadmapping process was beneficial in defining the environmental context, business drivers, strategies, and capabilities related to GFP's goals. IT needs were logically deduced from an understanding of what capabilities were required to support business goals, combined with an understanding of which ITs were available, considered to be best practice, and predicted by industry experts to have the most impact on forest products operations into the future.

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Term	Description
B2B	Business to Business (electronic commerce)
BoB	Best of Breed (highly specialized information system)
CAM	Computer Aided Manufacturing
COGS	Cost Of Goods Sold
CRM	Customer Relationship Management
CSF	Critical Success Factor
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FPI	Forest Products Industry
GFP	Gateway Forest Products
GIS	Geographical Information System
GPS	Geographical Positioning System
IOS	Inter-Organizational System
IT	Information Technology
LRF	Lumber Recovery Factor (# of board feet produced per cubic meter of log fiber)
Mfbm	1000 board feet
MOF	Ministry Of Forests
OTR	Operation and Technology Roadmap
PEST	Political, Environmental, Social, and Technological
RFID	Radio Frequency IDentification
SCM	Supply Chain Management
SISP	Strategic Information Systems Planning
SME	Small to Medium size Enterprise
SPC	Statistical Process Control
SWOT	Strengths, Weaknesses, Opportunities, and Threats
VMI	Vendor Managed Inventory
WWW	World Wide Web
XML	eXtensible Markup Language

INTRODUCTION

Information technology (IT) is defined as "all forms of technology used to create, store, exchange and use information in its various forms (Keen, 1995)."

Organizations struggle with determining how to use IT as a strategic weapon and incorporate IT resources into their existing business strategy. The value of IT is not always thoroughly understood by managers and relates to the classic debate called the "productivity paradox" (Brynjolfsson, 1993). If the benefits of IT are unknown, or are too difficult to measure, then maximizing return on IT investment becomes difficult. Implementing strategic information systems planning processes can help to maximize the return on IT investments.

The purpose of this paper was to analyze the strategic IT requirements of Gateway Forest Products (GFP) and to provide a plan outlining what, when, and how various ITs should be implemented. Strategic information systems planning (SISP) and IT roadmapping literature is reviewed in order to select and apply a framework to a practical case study.

The Fast-Start technology roadmapping process was selected for a case study of GFP to develop a high-level IT implementation plan. This process integrates classic strategic frameworks including the political, environmental, social, and technological (PEST) framework, Porter's 5-forces and generic value-chain (Porter, 1980), and the strengths, weaknesses, opportunities, and threats (SWOT) matrix with strategic IT planning. Current use of IT in the forest products industry (FPI) was researched so that best practices and expert opinions could be applied throughout the process.

INFORMATION TECHNOLOGY IN THE FOREST PRODUCTS INDUSTRY

A review of current literature on information technology (IT) in the forest products industry (FPI) has identified various IT best practices, expert opinions on the potential of IT to impact the FPI, and IT adoption trends. Much interest lies in the use of IT in supply chain management (SCM) because raw material and transportation costs account for a large proportion of cost of goods sold (COGS) for primary and secondary wood products.

Hetekami *et al.* (2005) have written a comprehensive review of IT use in the FPI. The article notes that large companies have more ability to implement IT systems because of a larger capital base. Historically, the FPI has concentrated on mass marketing commodity products to gain manufacturing efficiencies. The most fundamental advances have come from the use of ITs in managing and optimizing production processes to maximize the value of products produced from every sawn log. This is important since the cost of logs can account for as much as 60% of total product costs. Logs are sorted based on species, length, diameter and quality to improve production efficiency by minimizing parts movement. Secondly, the introduction of infra-red, x-ray and laser scanning systems combined with networking and computer-aided-manufacturing (CAM) systems have enabled rapid optimization decisions to recover maximum value from each unique log. Similar systems exist for increasing value of sawn boards with optimized edgers and trimmers. These optimization systems store and report information combined with current market prices so that managers and production superintendents can apply linear programming and simulation techniques to optimize value on an overall integrated basis. The information flows back into the system for further optimization, inventory control and accounting.

Automated quality control, grading, and sorting ensure highly efficient manufacturing operations and homogenization of products. Young *et al.*. (2000) test a semi-automated statistical process control (SPC) system costing less than $30,000 that has been estimated to produce benefits in excess of $180,000 per year.

Financial control and reporting systems are fundamentally important to forest products businesses. These traditional information systems include modules for human resource management, payroll, accounts payable, accounts receivable, general ledger, inventory control, and asset management. They are the systems which report operating profitably and provide insights into areas where costs can be saved or value can be added.

Technologies such as the World Wide Web (WWW), email, telecommunications and multi-media technologies for communication purposes are important to maintain strategic parity with competitors. Although such communication technologies are essential for conducting business in a multi-national or global organization, they do not relate to sustained advantage because they have been widely adopted at low cost.

Supply chain management (SCM) technologies are of increasing importance to the FPI since a large proportion of cost of goods sold (COGS) is made up of raw timber and transportation costs. A number of technologies are used to track, sort, and assign costs to raw logs. These technologies include physical tags, chemically modified or tinted paint, bar codes and radio frequency identification (RFID) tags. All of these technologies have been widely adopted, except for RFID tags which are considered leading-edge and expensive. Through the use of geographical positioning systems (GPS), geographical information systems (GIS) and far-reaching communication networks, it is feasible to coordinate the selection, harvesting, sorting and transportation of raw timber from central locations. The benefits from these coordination systems come from reduced inventory levels, a supply of high quality logs, and efficiently scheduled transportation and timber harvesting equipment. Tests of fully integrated supply chain management systems have shown 15-60% reductions in inventory levels and 20-30% improvements in delivery performance (on time, accurate and lower costs) (Hetekami *et al.*, 2005).

VanHorne *et al.* (2004) examine the role of SCM in the FPI and proposes the use of agent-based technologies as middle-layer interfaces between best-of-breed (BoB) heterogeneous IT modules. The resulting system of interconnected modules can then function like one larger cohesive ERP system. The paper provides context supporting the use of SCM. The FPI is "different from other resource based industries for several reasons; government ownership of the resource and strict control and changing regulations of procurement rights and practices, uncertainty with regards to quantity and quality of raw material; the transformation process is stochastic … and both divergent … and convergent … resulting in complicated and specific operations management methods." Major software vendors such as SAP, JD Edwards, Oracle and Baan have not addressed these unique problems in their ERP systems. Therefore, it is necessary to purchase from smaller IT vendors like Scoopsoft, IFS, and Savcor who supply the FPI with niche ERP systems. However, even these small ERP systems can be prohibitively expensive costing upwards of $100,000 dollars. It may be more feasible to purchase or develop niche modules and integrate them with agent-based middle-ware using standard technologies like EDI, XML and web services.

Craghead and Laforge (2003) discuss the role of SCM information systems. Supply-chain information systems aim to manage product flow through the value chain and include managing information related to suppliers, receiving, work-in-progress, finished goods inventory, customer order tracking and shipping. Key goals of SCM technologies are: schedule stability, reduced overtime, on-time delivery, quick response, ability to provide customer updates, reduced inventory levels, high throughput, high quality and strong relationships with customers and suppliers.

An emerging trend is for distribution centers and building suppliers like Home Depot to demand that wood products manufacturers implement vendor management inventory (VMI) systems in order to reduce inventory costs. VMI systems are a type of inter-organizational system (IOS). Because VMI systems are relatively new and highly integrated, they can be too expensive to implement for small wood products manufacturers (revenues less than $100 million / year). Therefore, the FPI has been slow to adopt VMI and IOS technologies. VMI systems are related to production, marketing, and sales planning systems. They goal is to reduce customer order errors, increase customer satisfaction, reduce product cycle times and reduce inventory levels, lower costs and increase perceived customer value.

Customer relationship management (CRM) systems are often integrated with VMI, marketing, and sales planning systems. Their goal is to document customer needs so that employees can more accurately and efficiently tailor products and services so that they are perceived to be of higher value. The value of these systems increases with the number of customers having different needs and tastes. Poku (2003) indicates that CRM systems are not highly leveraged in the FPI due to the industry's high production orientation.

Central to inter-organizational information systems is the idea of exchanging transaction information electronically over the Internet. Interestingly, Canadian companies in the FPI have adopted the use of the Internet more quickly than their US counterparts (Poku and Vlosky, 2004). Particularly important to the FPI are electronic business-to-business (B2B) relationships due to the nature of the wood products market and distribution network. Wood products are typically homogeneous commodities where manufacturing operations ship large quantities directly to wholesalers or building suppliers. Periodic purchases can be completed electronically with little fear of receiving incorrect or poor quality items.

Vlosky *et al.* (1994) discuss EDI implementation strategies for IOS technologies and confirm benefits such as reduced order time, inventory levels, transaction costs, number of errors as well as increased information quality, customer satisfaction, strong supplier/customer relationships and production/marketing coordination. It is also noted that implementations typically cost less than $1 million per company, but can still be too expensive for small organizations. Although these costs include networks, computers and software, they are largely a function of the number of trading partners and the level of system integration required. The main reasons for implementing EDI systems in order of importance are: requests from home center customers, cost reduction and efficiency, error reduction and expedited cash flows.

Manufacturing operations management (MOM) systems incorporate many elements of the already mentioned information systems into a single application. They are often called enterprise resource planning (ERP) systems since they cover most aspects of resource planning and manufacturing across multiple divisions. These systems combine market transaction data with production planning and scheduling to determine capacity and the supply of raw material, work in progress and finished good inventories to allow real-time reporting of financial information and fulfillment of customer orders. They also standardize business processes and information across divisions to provide a single seamless system for managing all company information. Unfortunately, ERP systems are often prohibitively expensive for small companies.

Hetemaki *et al.* (2005) attempt to predict the future of ITs in the FPI. They predict increasing customer demands with respect to 24-hour service, orders placed by phone or the Internet, real-time order tracking, and seamless transfer of transaction information will require increased investment in IOS and B2B e-commerce systems. Closer coordination of the supply chain will become increasingly valuable due to the increased complexity and sophistication of competitors and decreased supply of quality raw timber. Getting the right logs to the right manufacturing operations at the right time and at a low cost will become increasingly important. Backwards integration of GPS-enabled information systems into harvesting and transportation equipment will help coordinate raw material supply more efficiently and effectively. Further, benefits from ITs in the FPI will be through the development of collaborative business relationships with customers and suppliers facilitated by inter-organizational SCM systems.

Poku (2003, 2004) and Vlosky (2004) studied the impact of corporate orientation on IT adoption in the US FPI. Production-oriented companies focus on manufacturing productivity while minimizing costs and distributing products in mass quantities. Marketing-oriented companies take a holistic approach with an emphasis on identifying and fulfilling customer needs, with differentiation based on service level, quality and distribution. The studies found that a production orientation was historically predominant, but that companies in the FPI are gradually moving towards a marketing orientation. The findings indicate that the FPI is reactive and slower to adopt IT than industries with greater marketing orientation.

Poku (2003) notes that the WWW and email are the most popular Internet-based technologies. The major reasons for not adopting other ITs are a lack of understanding of IT benefits, fear of IT, fear of losing jobs, slow R&D efforts, and perceived lack of IT staff training in business processes. Major uses of IT include: researching market trends, competition and new technologies with the WWW; reducing B2B transaction costs, errors and delivery time through IOS; establishing better relationships with suppliers and customers with IOS; and improving manufacturing productivity through CAM and SCM systems. Increased competition, diminishing log diameter, reduced quality of timber and high transportation costs are major factors that increase the value of SCM systems.

Poku and Vlosky (2002, 2004) identify four other major factors affecting IT adoption in the US Forest industry. The first is existing IT efficacy. If a user already uses some IT systems to their advantage, then they will likely be more apt to try another. The second is user participation in the IT selection and implementation process. Participation is shown to have a positive effect on successful IT adoption. The third is perceived usability of new IT systems - employees hesitate to adopt information systems that they perceive are difficult to use. Lastly, employees will not adopt technology that they think will not be useful to them. In addition to the four factors outlined, an employee may also be hesitant to adopt IT if they fear that their job might be in jeopardy as a result.

Craghead and Laforge (2003) discuss the adoption of SCM information systems in the broader scope of manufacturing industries. Their SCM IT adoption model in Figure 1 follows the path from not adopting IT, to adopting internal systems, and then to adopting externally-linked systems. Hetekami *et al.* (2005) and Poku (2002, 2003, 2004) indicate that the FPI industry adopts other ITs in a similar manner.

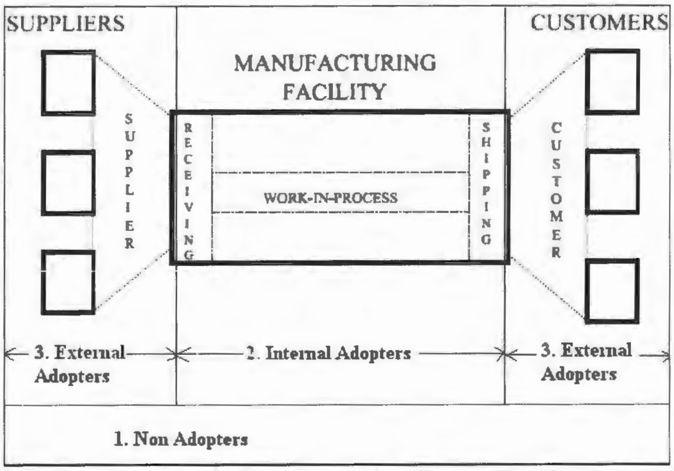


Figure 1 - IT Adoption Patterns in Manufacturing Firms (Craghead and Laforge, 2003)

STRATEGIC USE OF INFORMATION TECHNOLOGY

Much effort has been devoted to researching management, alignment and integration of IT with strategic management processes. The strategic IT literature, management theories, conceptual frameworks, and planning methodologies are based upon classic strategic theory.

Competitive External View

Clarke (1994) briefly outlines the development of strategic information systems theory. He reviews Michael Porter's traditional theories and frameworks including the 4 generic strategies (Figure 2), generic value chain (Figure 3) and 5-forces model of market competition (Figure 4).

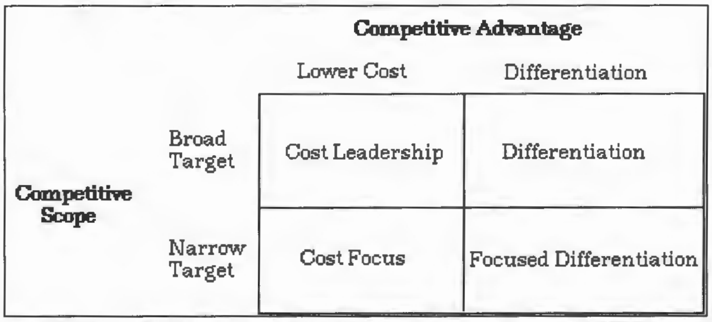


Figure 2 - Porter's 4 Generic Strategies (Porter, 1980)

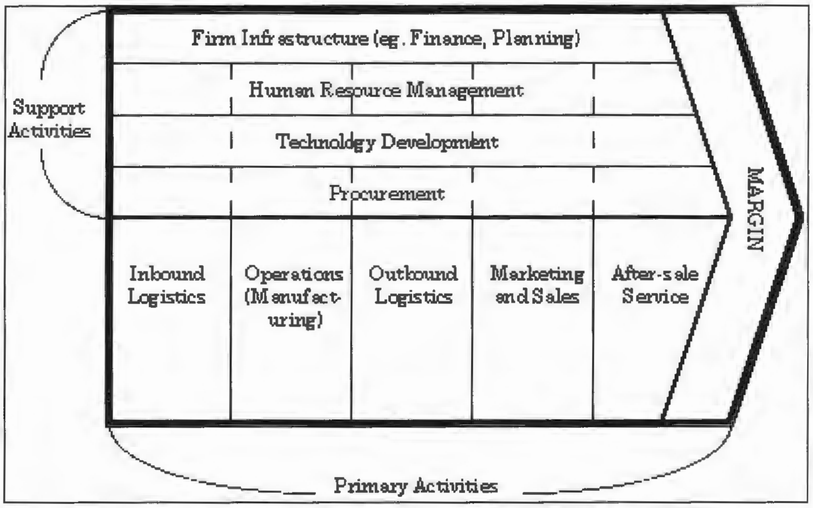


Figure 3 - Porter's Generic Value Chain (Porter, 1980)

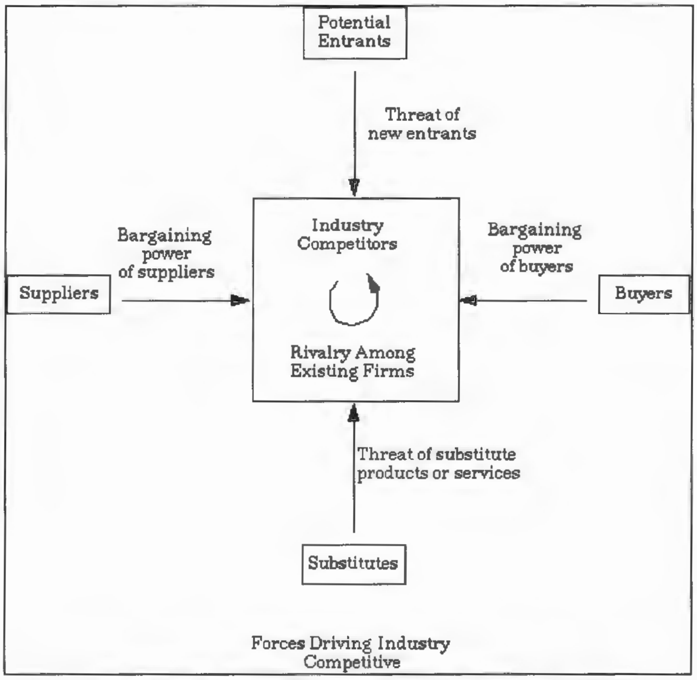


Figure 4 - Porter's 5-Forces Model (Porter, 1980)

Clarke (1994) indicates that IT implementations rarely lead to sustainable competitive advantage because they are usually easy to replicate or imitate. Although new ITs may lead to temporary first-mover advantage, they can be quickly replicated or outdated by newer, convenient, and cheap ITs which can give competition a longer-term second-mover advantage. Laggard IT adopters can often leverage investments and knowledge built through first movers. This is especially true where IT vendors experience intense competition, reduce prices, and improve quality at an incredibly fast rate. Clarke concludes that the strategic alignment of IT into holistic business processes can increase efficiencies and reduce transaction costs along communication boundaries resulting in short term competitive advantage. However, he does not offer much insight as to how or why ITs can produce the advantage.

Porter and Millar (1985) describe three ways that IT affects competition: by changing industry structure; by enabling efficient and effective processes to allow a business to outperform competitors without the same IT capabilities; and by spawning new business opportunities from existing operations. IT changes industry structure by: raising buyer power through increased information availability; raising barriers to entry when capital requirements for IT investment are high; enhancing CAM systems for increased manufacturing efficiency and agility; and strengthening supplier-buyer relationships through tightly linked inter-organizational communication systems. IT enables efficient and effective business processes by forcing information quality, consistency, storage and communication when implemented carefully. IT can also spawn new opportunities when businesses realize that information integrated into their products and services is highly valued by customers. In this case, a company can focus on delivering the valued information itself or spin off a separate company to provide the valuable information.

Porter and Millar (1985) categorize the sources of IT-based competitive advantage into 4 areas: lowering costs, differentiation, changing competitive scope, and spawning new business. Lowered costs occur with manufacturing and process optimizations, economies of scale (by redeploying slack resources) and lowered transaction costs (across divisional and inter-organizational boundaries). Differentiation through the use of IT results from incorporation of valuable information into products and services and from increased innovation and mass customization of products and services. Changing competitive scope refers to the ability of IT to bring geographically dispersed operations together under one large virtual cohesive unit. Finally, IT can urge businesses to re-assess their core competencies, and make completely new business technologically feasible.

Porter and Millar (1985) provide five steps to take advantage of IT opportunities. These five steps, outlined over 20 years ago, are still valid and consistent with current literature as described in the Strategic Information System Planning and Technology Roadmapping chapters in this paper. The first step is to assess the information intensity within current products and services. The second is to analyze how IT affects the five market forces. Thirdly, assess every point in the value chain to see where IT can provide insight into diversifying products and reducing costs. The fourth step is to see if IT can spawn new business. This step is highly dependant on the information intensity in your products and services. The last step is to prepare an implementation plan to take advantage of value-adding ITs.

Bakos *et al.* (1986) build on the concepts outlined by Porter and Millar (1985) and propose a framework for assessing the strategic importance of IT in 3 areas: internal strategy, competitive strategy, and business portfolio strategy. Further, the researchers indicate that underutilization of IT is a major problem. Although this article is 20 years old, researchers such as Brynjolfsson (1993), Morrison (1997), and Griffith *et al.* (1999) also claim that underutilization is a major factor reducing IT benefits.

Internal strategy is the focus on traditional IT functions to support management and business processes. The purpose is to analyze business processes and implement IT systems to make measurable (operations/unit of time and CSF) improvements in efficiency and effectiveness. Those implementing these IT initiatives often fail to consider holistic business strategies.

Competitive IT strategies are analyzed using Porter's 5-forces and generic value chain models. Competitive IT strategies are broken down into 2 sub-categories: comparative efficiency (internal and inter-organizational efficiency) and bargaining power (reduce supply search-related costs, differentiate products, and acquire bargaining advantages over customers and suppliers). Comparative efficiency stems from traditional IT business process streamlining within and between company borders. IT can also reduce the search costs related to the procurement of supplies due to increased ability to collect and process information on various suppliers' products and services. Gaining bargaining advantages over customers and suppliers typically result from implementing inter-organizational transaction systems. They reduce costs to source and buy products, and fix IT investments which contribute to increased switching costs and bargaining advantage.

IT can impact a company's business portfolio strategy in ways similar to those outlined by Porter and Millar (1985). Firstly, IT can provide the necessary information required to differentiate products and services to spawn new business. Secondly, IT can make new business technologically feasible by providing supporting services. For instance, the availability of detailed operating information may require the expertise of an operating consultant to decipher that information. Thirdly, increased efficiency causes excess capacity which must be redeployed to new productive activities. Lastly, IT increases the availability of market information allowing one to more easily analyze new business opportunities.

Devaraj and Rajiv (2002) re-iterate the importance of using Porter's 5-forces and generic value chain models in determining which strategic IT investments to make. Similar to Bakos *et al.* (1986), the authors suggest a two-part general process of "looking outward" and then "looking inward". Looking outward makes reference to using Porter's 5-forces and performing environmental scanning. Looking inward means keeping the results of looking outward in focus while assessing strengths, weaknesses, opportunities and threats (SWOT analysis) and then using Porter's generic value chain to determine where IT will have the greatest impact on creating value or driving down costs.

Resource-Based Internal View

The resource-based view of competitive advantage is a useful framework for analyzing sustainable advantage. Grant (1991) details the use of a resource-based framework in strategy formation. He proposes a five stage framework (Figure 5): analyze resources using a SWOT framework; appraise unique firm capabilities arising out of resources; analyze long-term profit earning and retention potential from identified resources and capabilities; select a strategy to best exploit these resources and capabilities; repeat the process to upgrade resources, capabilities and strategies to earn long-term profits.

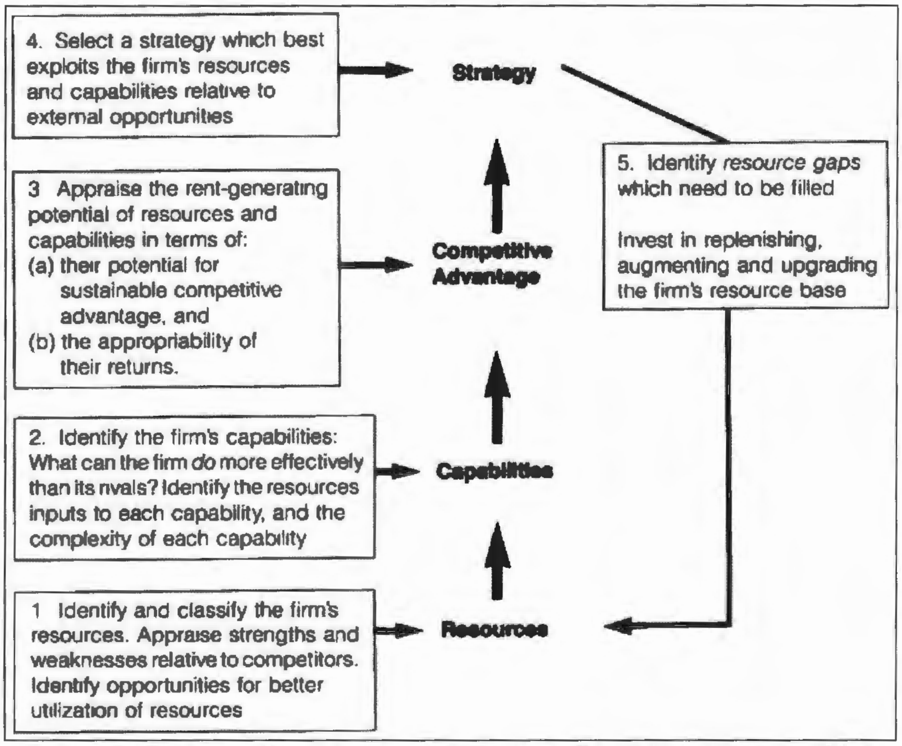


Figure 5 - Resource-Based Approach to Strategy Formulation (Grant, 1991)

Grant indicates that resources are not productive in and of themselves. A capability is the productive capacity for a team of cooperative and coordinated resources to perform some task or activity. Therefore, capabilities are the source of competitive advantage. This argument should be applied in the same manner to the ability of IT resources to contribute to competitive advantage. Further, Grant indicates that competitive advantage is eroded through depreciation of resources and capabilities and through imitation by rivals. The speed of erosion depends on characteristics of organizational resources and capabilities. The loss of advantage is related to the concepts of resource and capability durability, transparency, transferability, replicatability, and appropriability (the ability of a company to retain the benefits of its resources and capabilities).

Mata *et al.* (1995) uses the resource-based framework under the general headings of resource heterogeneity and immobility to analyze the sustainable advantage of IT investments. Mata *et al.* (1995) examine the effect of history, causal ambiguity, and social complexity on the heterogeneity and immobility of resources. Being at the right place at the right time can help build heterogeneous resources. Further, the more causally ambiguous a firm's resources and capabilities are, the more sustainable will be the advantage. For instance, intangible and invisible intellectual assets built upon a large number of small decisions will be hard for a competitor to imitate. This is related to social complexity. Culture, reputation, trustworthiness are difficult to change quickly and can be a source of advantage when these social factors lead to low costs or uniquely differentiated products.

The analysis undertaken by Mata *et al.* (1995) focuses on 5 attributes of IT: effect on switching costs, capital requirements, proprietary technology, technical IT skills, and management IT skills. The study concludes that only management IT skills can lead to sustainable competitive advantage. History has shown that customers are angered when they perceive a firm is trying to increase switching costs and will strive to reduce these costs or take their business elsewhere. Investing in expensive IT systems may lead to sustained competitive advantage only if the competition cannot afford to implement similar systems over a long period of time. Given the high level of competition among IT vendors and the fast pace of IT innovations, the reality is that the cost of any IT is bound to decline within a few years of its first implementation. Further, it may even be advantageous to be the second-mover to gain long term cost advantages over first-movers. Although proprietary IT may allow a temporary advantage, it is not likely to be a source of sustained advantage. Firstly, IT applications are difficult to patent. Even if they were, they would be costly to enforce through continual policing and litigation. Therefore, secrecy is the only way to keep IT proprietary, unless a company has a large financial base. However, it is difficult to keep proprietary technologies secret, which rules out the possibility of leveraging proprietary IT for sustainable advantage. Non-specialized technical IT skills are shown not to be a source of sustainable advantage because they are becoming widely available and low cost. Lastly, high quality managerial IT skills can be a source of competitive advantage because of the degree of history, causal ambiguity and social complexity involved in their development.

Powell and Dent-Micallef (1997) also use the resource-based framework to argue that tightly integrated IT, human, and business resources lead to competitive advantage. Empirical evidence concludes that there is a positive correlation between firm performance and tightly integrated IT, human and other business resources. However, the study did not prove causality – a common criticism of empirical studies linking IT investments to business performance.

Bharadwaj (2000) recognizes the contributions of Mata *et al.* (1995) in determining the possible sustainable advantage of high quality management IT skills. The author excludes IT infrastructure as a source of sustainable advantage and calls attention to IT-enabled intangibles for their heterogeneous and immobile qualities as the major source of IT-based competitive advantage. Such IT-enabled intangibles include knowledge assets, especially tight relationships with suppliers and customers and other synergistic relations.

Empirical evidence is shown positively correlating the relationship between IT capabilities (based on IT budgets, size of IT staff and adoption of specific technologies) and business performance (return on investment).

INFORMATION TECHNOLOGY REQUIREMENTS ANALYSIS

The technical aspect of assessing which IT systems a company should implement is called requirements analysis or requirements determination. The focus is on gathering and soliciting details relating to what an IT system should do in terms of where input comes from, what the inputs actually are, what processing should occur, what output is needed and who or what system needs the output.

Davis (1982) describes a number of methods used to gather requirements for what he calls a "Master Plan." The master plan is essentially a high-level description of what an overall information system must accomplish for the business. The master plan defines the overall system architecture, establishes a portfolio of applications or modules to provide logical sub-sets of functionality, establishes clear and well-defined boundaries for those modules, and specifies an orderly development plan of the modules. Strategies for information requirements determination are as follows:

- Asking – open and closed interviews, brainstorming, and panel interviews. Asking incorrectly assumes that the user has complete grasp of their information needs and is time intensive.
- Deriving from an existing system – requirements can be gleaned from a system being replaced, from another organization, or from descriptions in textbooks, journals, and other studies. This is often the simplest and quickest method, although it is not guaranteed to be representative of actual business needs.

- Synthesis from characteristics of a utilizing system (requires input from another system) – input requirements for an existing information system can form the specification of the outputs for the unknown information system. This could be hand-written management reports, critical success factors (CSF), input specifications of another IT system, or the result of business process redesign. A systems approach related to CSF works backwards from high-levels of information required and determines what information needs to be aggregated to provide the higher level information.
- Discovery from experimentation and prototyping – agile software development systems involve incremental development and focus on close relationships between non-technical IT users and technical developers. It is becoming increasingly popular for developing systems where users have little understanding of their information requirements or where IT projects are risky.

Byrd *et al.* (1992) present 4 stages of requirements analysis. The first is conceptual design. This involves developing models reflecting CSFs that affect system design and includes analyzing environmental forces, company wide goals, current and future problems, and product/service flows. The second is logical design, which assesses the strengths and weaknesses of conceptual design related to organizational (resources, maturity, attitudes, politics, priorities) and technical (existing system capabilities, data availability, personnel) factors. The third stage performs a validation of requirements determined up to this point. People reviewing requirements inspect methods of data entry, processing and output. The last stage is a formal specification which clearly and completely specifies the information processing requirements. This project will produce a high level strategic IT plan instead of a formal specification. Common requirements analysis techniques are shown in Table 1.

RA Technique	Description
Behaviour Analysis	Observe user or expert doing a specific task.
Prototyping	Develop iterative and incremental versions of the system.
Open Interview	Ask users and experts to describe specific tasks. This technique is not appropriate for detailed requirements because human memory is incomplete and unstructured.
Brain Storming	Identify as many requirements as possible, select the most important, and elaborate on them using other requirements analysis techniques.
Goal-Oriented	Identify high-level requirements and work incrementally towards more detailed sub-requirements.
Variance Analysis	Use existing systems as a basis to expose deviations from the desired system. This technique helps users form a conceptual reference for new requirements.
Structured Interview	Use open, closed, probing and leading questions to maintain focus and obtain information on specific topics. This technique is often used to elaborate high-level requirements.
Critical Success Factors (CSF)	Identify essential indicators of firm performance and use these requirements of information to drive a goal-oriented approach.
Future Analysis	Predict possible changes in the external environment and internal resources and try to mitigate risks and explore opportunities.

Table 1 - Requirements Analysis Techniques (Byrd *et al.*, 1992)

Although these articles on requirements analysis are quite old, the classic concepts which are described are widely applicable today in both SISP and technology roadmapping.

STRATEGIC INFORMATION SYSTEM PLANNING

Strategic information systems planning (SISP) attempts to bridge the gap between technical implementations and business requirements. Earl (1993) discusses five approaches to strategic information systems planning (Table 2).

SISP Approach	Description
Business-Led	Analyze business plan to identify uses of IS
Method-Driven	Use formal requirements analysis techniques to identify IT opportunities. These formal techniques are time consuming, but often lead to more complete and detailed requirements.
Administrative	Plan resources as part of a top-down budgeting process. This rarely leads to innovative ideas or strategic thinking.
Technological	Engineers use analytical models to map activities, processes, and data flows. This is similar to the method-driven approach, results in a formal requirements specification, and is time consuming.
Organizational	This multi-dimensional approach uses subtle language and emphasizes process, teamwork and collaboration. Systems are broken down into distinct modules and delivered on a scheduled timeline.

Table 2 - Strategic Information Systems Planning Approaches (Earl, 1993)

The organizational approaches tend to give the best results because of their focus on collective learning, collaboration, and continuous improvement of IS functions through teams, task forces and workshops. It has been shown by other researchers that socially complex and integrated IT functions that lead to intangible and valuable knowledge assets are the most likely to lead to sustainable competitive advantage. Therefore, organizational SISP is likely to provide the most benefit in analyzing IT requirements.

Lederer and Salmela (1996) propose a framework with seven constructs (Figure 6) for performing SISP: external environment, internal environment, planning resources, planning process, information plan, implementation plan, and alignment of the information plan with the business plan. The emphasis is on aligning IT plans with business plans. This is a problem since IT-based sustainable advantage results from integrating the SISP process directly with strategic business planning. Separating the plans and centrally administering information resources will alienate, instead of tightly integrating, business resources.

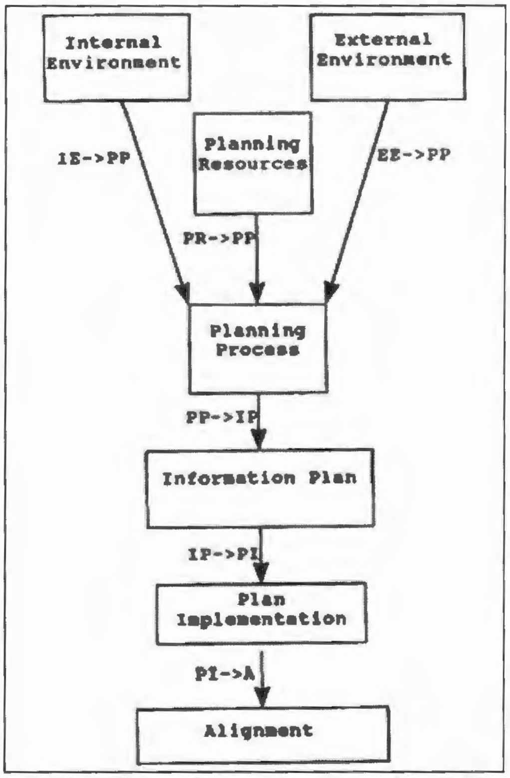
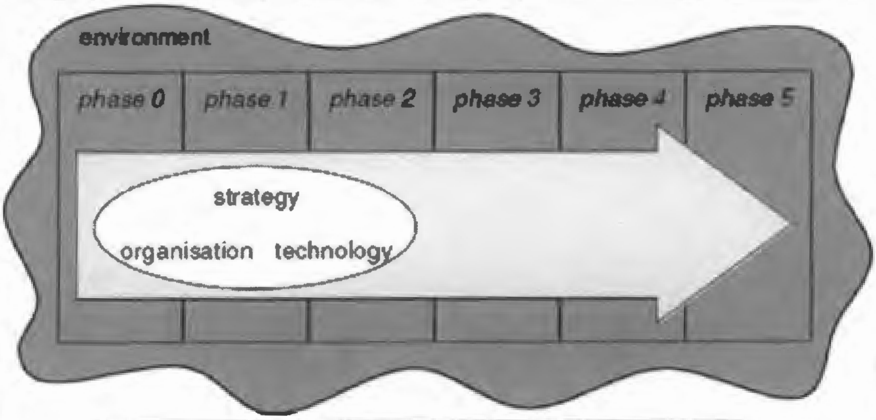


Figure 6 - Theory of Strategic Information Systems Planning (Lederer and Salmela, 1996)

Knol and Stroeken (2001) discuss a framework which incorporates elements of SISP into an IT diffusion and adoption model. The framework constructs of environment, strategy, organization, and technology are shown to have varying effects on SISP through a series of IT adoption phases. The framework is especially useful for small and medium sized enterprises (SMEs), which tend to display characteristics of earlier phases. The environmental construct consists of macro-economic, technological, demographic and market developments. Figure 7 gives a brief description of the five IT adoption phases and has a high correlation with manufacturing adoption patterns in Craghead and Laforge (2003) and SISP theories forwarded by Earl (1993) and Knol and Stroeken (2001).



Phase	Description
0	No usage of information technology
1	Internal oriented functional integration
2	Internal oriented multifunctional integration
3	External oriented process integration
4	Business process redesign
5	Business scope redefinition under influence of IT

Figure 7 - Strategic IT Diffusion and Adoption Model (Knol and Stroeken, 2001)

TECHNOLOGY ROADMAPPING

Technology roadmapping combines traditional strategic frameworks with SISP into a holistic approach culminating with a forward-looking, practical, and easily communicable technology implementation plan. Industry Canada developed a comprehensive technology roadmap for the lumber and value-added wood products industry. However, their FPI technology roadmap pays little attention to IT.

Generic Technology Roadmapping

Industry Canada (2000), Bray and Garcia (1997), and Garcia and Bray (1998) present an overview of a generic industry-wide technology roadmapping processes. Although the scope of industry-wide roadmapping is much larger than is needed for the purpose of this paper, the concepts are still applicable to organization-level technology roadmapping. The technology roadmapping process is mainly driven by “market pull.” Market pull refers to the increasing demand of customers for innovative and low cost products and services. For instance, if vehicle owners need to reduce fuel consumption in half by the year 2010, then innovative technologies are required to accomplish that goal. This is opposed to "technology push," where one determines what can be accomplished with existing technologies. Secondly, technology roadmaps build upon company-level and industry-level visions of the future. Lastly, a technology roadmap provides a practical route for achieving these visions by providing a process to identify, select and develop supporting technologies.

Roadmaps are especially useful for selecting technologies when a business vision is known and the path of technology adoption to support the vision is uncertain. Although there is no best roadmapping process to suit every situation, the basic process can be broken up into 3 stages. It is recommended to customize the process for the unique circumstances of each application.

The first stage in developing a technology roadmap involves performing preliminary activities such as defining the purpose, environmental context, scope, timeline, resources required, dedicated leadership and participants.

The second stage develops the roadmap itself and is divided into multiple sub-tasks. The first task is to refine the purpose and set quantifiable goals or CSFs for the technology roadmap to achieve. The second task defines the current state and future outlook of the industry in terms of products, services, customers, suppliers, competition and regulation. The third step is to identify the products and services that will be the focus of the roadmapping process. The fourth task is to identify the critical attributes of those products and services, how technology can affect those attributes, and when those technologies will be needed. Specifying technology drivers and their targets related to critical product and service attributes will help flesh out the appropriate implementation schedule. The fifth task is to identify alternative technologies that may help achieve target product and service attributes. The last task is to recommend specific technologies, schedule when milestones should be achieved, and define the skills and knowledge the workforce must attain in order to implement the roadmap.

The last stage of the technology roadmapping process allows for continual renewal of business strategy. It is important to critique and validate roadmaps both when they are initially completed and at regularly scheduled intervals. Seeking feedback from all involved participants is considered best-practice. The problem with the generic roadmapping process is that it involves numerous steps that may not be clear and intuitive to follow. Garcia and Bray (1998) organize the roadmapping process into a succinct process (Figure 8).

Phase I. Preliminary activity
1. Satisfy essential conditions.
2. Provide leadership/sponsorship.
3. Define the scope and boundaries for the technology roadmap.

Phase II. Development of the Technology Roadmap
1. Identify the "product" that will be the focus of the roadmap.
2. Identify the critical system requirements and their targets.
3. Specify the major technology areas.
4. Specify the technology drivers and their targets.
5. Identify technology alternatives and their time lines.
6. Recommend the technology alternatives that should be pursued.
7. Create the technology roadmap report.

Phase III. Follow-up activity
1. Critique and validate the roadmap.
2. Develop an implementation plan.
3. Review and update.

Figure 8 - Technology Roadmapping Process (Garcia and Bray, 1998)

The Commonwealth of Australia (2001) present a guide to developing technology roadmaps that resembles the three phases and sub-steps identified by Garcia and Bray (1998). The guide considers three approaches to developing technology roadmaps:

drawing on knowledge of industry experts; engaging stakeholders from the industry, government and research workshops; and utilizing detailed information gathered through academic information sources like journals and computer databases.

Kostoff and Schaller (2001) indicate that computer database driven approaches tend not to produce high-quality technology roadmaps. They neglect the some of the most valuable aspects of SISP – the creation of difficult to imitate management IT processes and socially complex relationships which are shown to be the only sources of IT-based sustainable competitive advantage. Expert-based approaches result in better technology roadmaps, as long as SISP processes are combined into an integrated and iterative approach.

Key elements of highly successful roadmaps include making bold business and market visions, establishing a clear sense of purpose and ownership, selecting competent and committed participants and leaders from varying backgrounds, preparing clear and concise roadmap development processes, and focusing on practical technology implementations (Commonwealth of Australia, 2001).

Fast-Start Technology Roadmapping

The generic technology roadmapping process can be time consuming and costly to implement in practice. Phaal *et al.* (2000, 2001a, 2001b) developed a practical framework called Fast-Start for expediting the technology roadmapping process. Their technology management framework recognizes that IT resources must be planned in conjunction with other businesses resources in light of organizational and environmental context and core business strategies. This is consistent with competitive strategy literature and the resource-based view of firms.

Major constructs of the Fast-Start technology management framework include: the operating environment (markets, customers, competition, regulation); the business level (organization, networks, business portfolio, marketing and financial functions, and strategy development); the product level (portfolio of products and services, manufacturing and operations, innovation); technology (existing technology and the innovation and skills required to use and maintain a technological base); and time. The technology management framework presented in Phaal *et al.* (2000) (Figure 9) is quite similar to the one proposed by Knol and Stroeken (2001). Phaal *et al.* (2001a and 2001b) use an updated technology management framework showing how technology management processes (identification, selection, acquisition, exploitation and production) and business processes (strategy, innovation and operations) are combined to bridge the gap between commercial and technological perspectives (Figure 10). Both technology management frameworks relate directly to the generic technology roadmap in Figure 11.

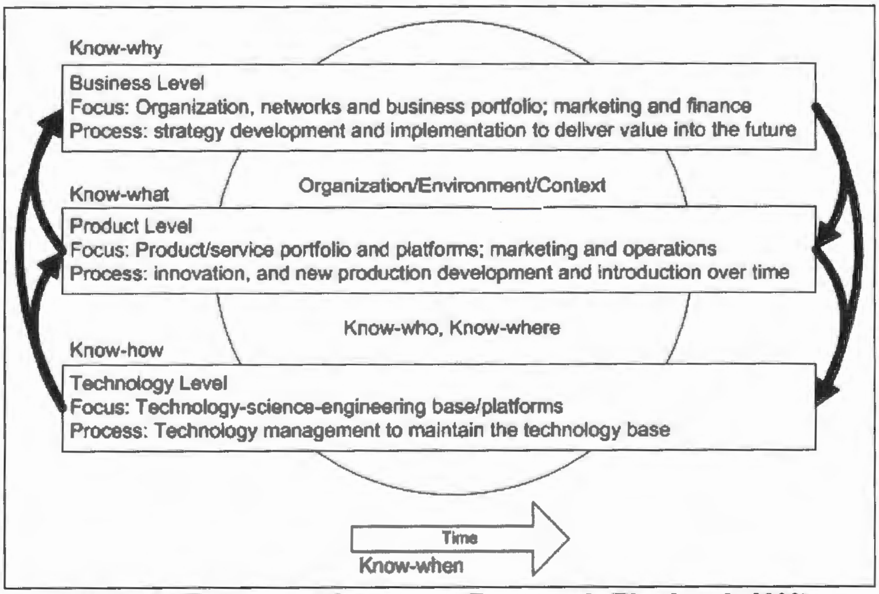


Figure 9 - Technology Management Framework (Phaal *et al.*, 2000)

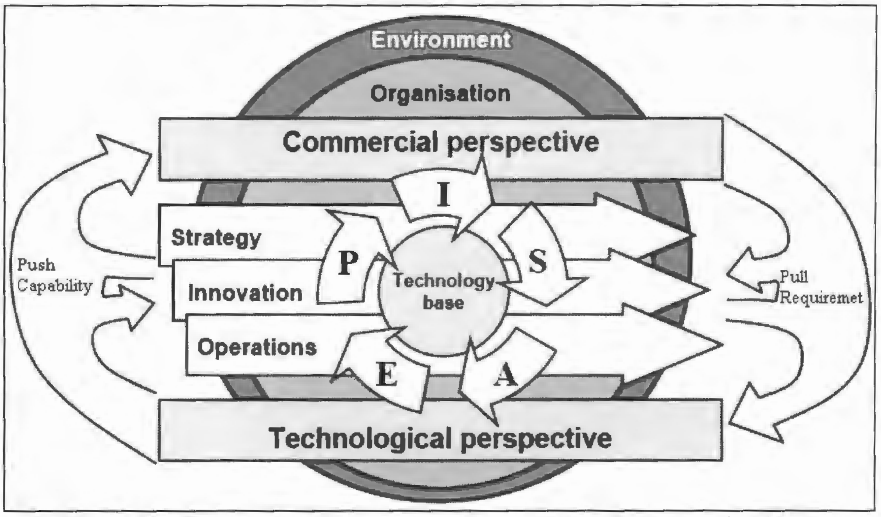


Figure 10 - Technology Management Framework (Phaal *et al.*, 2001a)

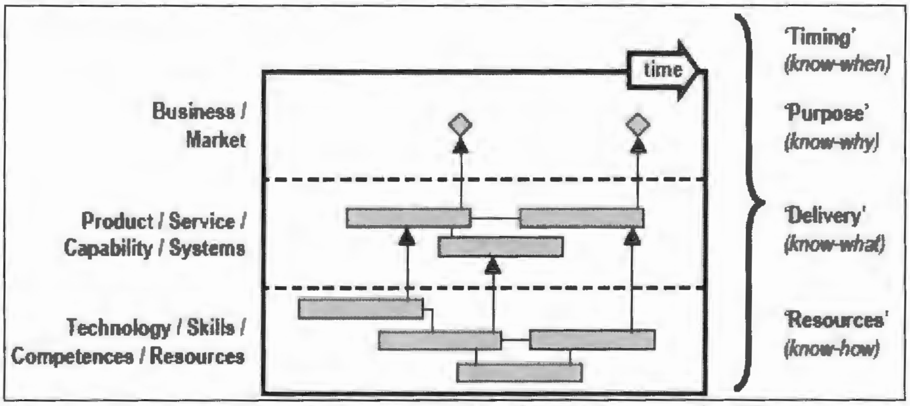


Figure 11 - Generic Technology Roadmap (Phaal *et al.*, 2001a)

The top layer of the roadmap represents the organizational purpose that is driving the roadmap. The bottom layer represents the resources (particularly technological, but can include other resources) that will be deployed to address demands from the top two layers. The middle layer of the roadmap is critical and provides a bridging mechanism between business purpose and resources. The middle layer frequently focuses on products, but may also focus on the services, capabilities and opportunities through which technology is deployed to meet business demands.

Phaal *et al.* (2001b) present a number of different categorizations and representation formats of technology roadmaps. The three categories which seem most appropriate for the context of this research include product, service/capability, and strategic planning roadmaps. The two formats that seem most appropriate are the multiple layers diagram (Figure 11) and the documentation format (Appendix 1). The authors suggest augmenting the planning processes and roadmap formats to suit the unique needs of the industry or company being analyzed.

The Fast-Start technology planning approach is comprised of four facilitated workshops (Figure 12). The first three workshops focus on three key layers of the roadmap (market/business, product/service/capability, and technology/resources) and the final workshop combines the three layers into a time-series representation.

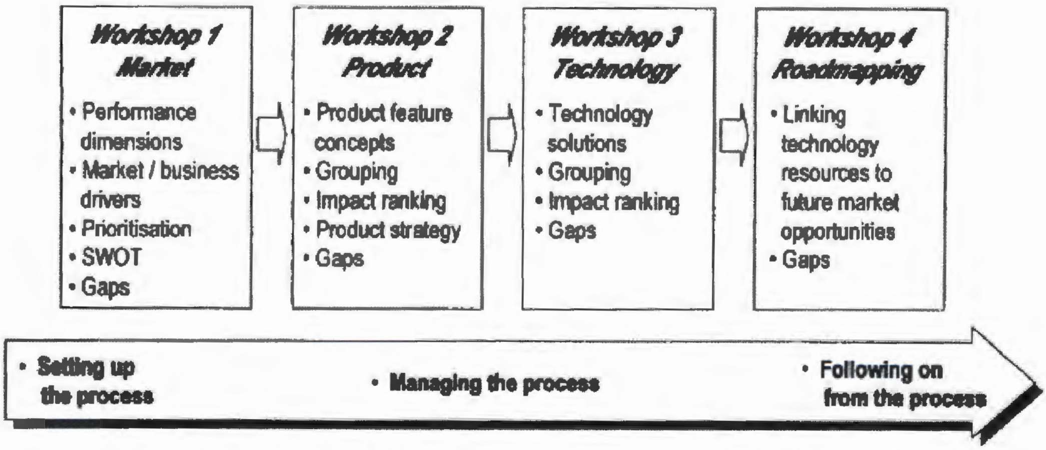


Figure 12 - Fast-Start technology roadmapping process (Phaal *et al.*, 2001b)

Technology Roadmapping for Small and Medium Enterprises

Chesher *et al.* (2000) and Holmes *et al.* (2004) discuss the application of technology roadmapping to SMEs. Both studies agree that SMEs are slow to adopt technologies and SISP processes compared to larger competitors. Further, both papers stress the value of initially assessing an organization's current position. Holmes *et al.* (2004) separate the first Fast-Start roadmapping workshop into 2 workshops to emphasize priority on these initial steps, and call the framework operation and technology roadmapping (OTR).

Chesher *et al.* (2000) focus on IT adoption and indicate that varying levels of user IT sophistication provide a major construct in an IT adoption roadmap. Lack of IT skills, time, financial resources and perceived value of ITs are blamed for slow IT adoption patterns in SMEs. The stages of IT user sophistication include: inactive (do not use IT), basic (use word processing and other desktop software), substantial (use networked communication technologies and other networked applications) and sophisticated (involved with many integrated applications and use ITs to achieve product and service differentiation). Technology roadmaps for SMEs should focus heavily on developing employee IT skills and capabilities to make best use of ITs. Table 3 outlines best practices for increasing the level of IT sophistication.

Level of IT Sophistication	**Best Practices**
Inactive	Focus on training. Introduce concepts of IT with strong business context, illustrating critical impacts and benefits. Extend use of desktop software
Basic	Develop an action plan to achieve business objectives and develop a roadmap of how technologies can help achieve those business goals.
Substantial/ Sophisticated	Provide assistance with consulting, project management, preparation of requirements specifications and requests for proposals.

Table 3 - Impact of IT Sophistication Level on IT Adoption (Chesher *et al.*, 2000)

METHODOLOGY

The selection of a set of frameworks, methodologies and processes is critical to analyzing IT requirements for any business. A number of frameworks and methodologies have been presented in literature which attempt to drive the strategic selection, implementation, and effective use of technology, given unique external environmental conditions and internal organizational resources and competencies.

Strategic frameworks and methods like PEST analysis, Porter's 5-forces, value chain analysis, the resource-based view, and SWOT matrices are useful for strategic business planning. However, managers often find it difficult to integrate the IT planning into standard strategic planning processes.

Technology roadmapping frameworks provide an effective method to integrate technology planning into a holistic business planning process by encouraging managers to think about and communicate how technology can support organizational capabilities to achieve quantifiable business objectives. Therefore, the technology roadmapping process has been selected for analyzing current and future IT requirements to support the objectives of GFP.

One must consider the availability and sophistication of a company's resources that it has to devote to a SISP process. Phaal *et al.* (2000, 2001a, 2001b) indicate that application of a technology roadmapping processes can be costly and time consuming. Holmes *et al.* (2004) stress the importance of an initial assessment of company resources and capabilities in the roadmapping process when working with SMEs. Chesher *et al.* (2000) suggest that the adoption of ITs by SMEs can be facilitated by paying special attention to the level of user sophistication in the development of an IT roadmap. For these reasons, and because GFP is a small enterprise, the Fast-Start technology roadmapping process was selected and customized to pay close attention to the overall level of IT sophistication.

Six facilitated workshops, each lasting two to four hours, were undertaken at GFP in order to develop the IT roadmap. The researcher performed the role of the facilitator in each of the workshops with GFP's operating committee. The operating committee included the general manager, woodlands manager, and one major stockholder and active member of the board of directors (see Appendix 3). Information collected regarding IT use in the FPI was used as a set of possible IT requirements which the IT roadmapping could evaluate in light of GFP's strategy, operating environment, and existing resources. The researched expert opinions regarding which technologies could provide the most future benefit were also taken into account.

Each of the workshops contained elements from the techniques outlined in the requirements analysis and SISP literature. The workshops were panel interviews with GFP's operating committee which included elements of open and closed questions, brainstorming, and development of requirements based on CSFs as described by Davis (1982). The requirements analysis techniques used in the workshops are related to the goal-oriented, structured interview, CSF, and future analysis techniques as described by Byrd *et al.* (1992). As recommended by Earl (1993) the IT roadmapping process represents an organizational SISP approach and incorporates environmental conditions, internal resources and company strategy to develop a high-level IT implementation plan.

The first two workshops concentrate on assessing GFP's current business strategy, environmental context and state of IT resources (human and technical). Attention was given to technology adoption patterns identified by Craighead and Laforge (2003), Poku (2003), Poku *et al.* (2004) and Knol and Stroeken (2001). The major environmental conditions from the first workshop form the top layer of the IT roadmap. The third, fourth, and fifth workshops relate directly to the business, capability, and IT resource levels of the IT roadmap. The last workshop concentrated on mapping the various components on a graphical time line representation.

RESULTS AND ANALYSIS

Gateway Forest Products

GFP was formed in September 2004 to capitalize on a strong lumber market and highly available, low cost timber. The intent was to initially focus on manufacturing dimensional lumber and to eventually supply high margin niche wood products. Initial construction of the sawmill was completed in October 2005. Operational flow and organizational charts are included in Appendix 2 and Appendix 3, respectively. The operational flow chart is followed as a framework to identify ITs related to each point in the value chain. Most of GFP's 30 employees are involved in receiving, sorting and sawing logs into dimensional lumber since they have no planer capacity. Only 2 people source raw logs and 2-3 people are involved in marketing and logistics. GFP is a relatively small player in the FPI with annual revenues estimated to be between $10 and $20 million dollars per year.

Workshop 1 – Purpose, Environment and Strategy

The first workshop focused on communicating the technology roadmapping process to GFP and defining the purpose, scope, vision, and environmental context to frame the top-level dimensions of the technology roadmap.

Purpose, Scope and Vision

Determining how to allocate scarce resources on IT is an interesting problem in the context of a newly formed company because there are numerous potential investments to choose from. The purpose of developing an IT roadmap was to identify, evaluate and select ITs for implementation that will produce the highest return on investment given

GFP's environmental conditions and business strategy. Of particular interest were information systems which help relate business decisions and activities directly to bottom line profitability. The scope is therefore limited to information systems which relate cost or value to specific business activities.

Sandy Long, Woodlands Manager of GFP indicated that "Gateway is a relatively small player in the lumber industry and recognizes many challenges moving forward. Particularly, the impact of the pine beetle on our timber supply, government regulation on stumpage prices, reliance on commodity lumber prices, and deep pockets of large competitors will pose some of the greatest threats to our profitability. However, unlike our highly capitalized competition, we can adjust our log diet, operations and product mix to changing market conditions and consumer tastes more quickly with lower costs." An IT system must allow GFP to experiment with new log diets, operations and products and to accurately report profitability without performing complex manual calculations. Profitability of stable operations should be identifiable and traceable on a daily, weekly and monthly basis.

PEST Analysis

GFP's environmental conditions were analyzed to form the first construct of the technology roadmap. A standard PEST framework was chosen for simplicity. Various information systems were related to the main points of this analysis to see where IT can assist in minimizing the risks associated with GFP's operating environment.

Political
Tariffs and quotas might not be reduced in the future.
The Ministry of Forests (MOF) may initiate another takeback from large companies to increase the availability of timber to smaller companies.
Stumpage rates are being increased for certain types of timber for specific companies.
The MOF has negotiated stumpage rates with various parties and one-sidedly increased the rates in those contracts. This relates to a high level of uncertainty.
The MOF has predicted a large drop in the annual allowable cut within 10 years.
Increased industrial safety regulations require tighter safety controls.

Economic
Canada/US exchange rate risk exists for companies that cannot afford a hedging program. The relatively declining US dollar increases Canadian producers' costs while reducing the value of lumber exports.
Skilled workers and trades are becoming more difficult to find and retain.
Availability of cheap credit supports the housing market and lumber demand.
Rising interest rates increase the cost of borrowing, dampen the housing market, and decreases demand in the lumber market.
The pine beetle epidemic is reducing the value of interior BC timber.
The cyclical lumber industry might be on a down cycle. Historical price per Mfbm falls between $200 and $400 US, averages $300 US, and is currently US $323/Mfbm (RBC Financial Group, April 2006).

Social
Increasing popularity of home renovations increases lumber demand.
The do-it-yourself renovation fad increases demand for high-quality lumber in large retail building centers. Boards with stain or wane are not desired.
There is a trend towards using perceived environmentally friendly building materials like plastics, concrete, steel studs and engineered wood products. Some environmentalists have degraded the lumber industry's image.

Technological
Engineered wood products are becoming more appealing due to consistent quality. GFP could provide stock for companies producing engineered wood products.
High-tech scanning and optimization equipment have increased sawmill productivity.
There is only a small information component to wood products and services.
B2B IT systems reduce transaction costs of doing business with high volume customers.
Integrated supply chain, manufacturing, and sales management systems are being developed to optimize the entire value chain.
IT systems to coordinate logs with the appropriate sawmill are seeing large benefits.
The technology diffusion rate is historically slow in the FPI, but is increasing.
Automated grading and trimming is becoming more reliable, but is still expensive.
Statistical quality and process control systems are moving from batch and random sampling to continuous monitoring, increasing productivity.

Porter's Five Forces Analysis

Porter's five forces model is usually used to examine market forces at the industry level. However, the five forces model was used here to examine the wood products market forces relative to GFP at the company level. This analysis was useful to determine how IT systems can reduce the relative power of each of these five forces over GFP. All of the market forces are high except for barriers to entry and the threat of substitutes, which exhibit moderate force.

Supplier Power - HIGH
GFP, a relatively small company, has little power and influence over the MOF and large controllers of open market timber. Since the MOF controls the majority of timber resources in BC, GFP has low power over timber suppliers overall.
GFP has positive and close working relationships with forestry contractors and can exert a large amount of influence over those operations.
GFP has little power over skilled contractors and tradesman due to the shortage of highly qualified tradesman in the Prince George region.
Alternative sources of wood fiber such as aspen are available, but unproven.

Buyer Power - HIGH
GFP has little power over pricing. Since there are numerous buyers and sellers of homogeneous products, prices are taken at market value.
GFP sells all products through a wood products broker and has limited market influence through their broker. A portion of sales are committed to Canfor to fill gaps in customer orders. Any power over Canfor is offset because Canfor purchases wood chips from GFP.
Large home centers prefer to purchase large quantities of wood products through large companies like Canfor to capitalize on economies of scale. Therefore, GFP is limited to distributing products through their broker
Canfor's regional pulp mills buy all of GFP's chips at a dictated price since they are not dependant on GFP chips. There are few alternative chip buyers.

Barriers to Entry - MODERATE
Relative to large competitors, huge capital expenditures (over $100 million) are required to obtain absolute variable cost advantages with specialized equipment.
It is relatively inexpensive (less than $10 million) to start less optimized operations to produce wood products in smaller quantities.
Limited access to large economically viable sources of timber will form the largest barriers to entry within the next 5 to 10 years.
A steep learning curve with regard to wood supply, technology, and distribution presents further barriers to entry.
There is limited access to distribution channels. New operations must find customers or brokers capable of selling large batches of products to achieve economies of scale.
Historically low profits and cyclical profitability discourage new entrants.

Threat of Substitutes – MODERATE
Few switching costs exist for buyers of commodity lumber products.
Viable alternatives to wood products are being developed at an increasing rate. However, using non-wood building materials are still considerably more expensive and require going through an initial costly learning curve.

Degree of Rivalry - HIGH
High barriers to entry increase the degree of rivalry. Competitors will explore every other option before shutting down operations and liquidating inventory and equipment.
The regional wood products industry is heavily concentrated and contributes to intense competition for highly skilled trades, log supply, and distribution channels.
The commodity wood products market is mature in terms of growth. Intermittent overcapacity (caused by capital intensity and desire to exploit economies of scale) contributes to intense rivalry.
The regional wood products industry seems to be characterized by a level of discipline which allows some collaboration to occur.
Firms are sophisticated enough to not initiate price cutting strategies.

Value Chain Analysis

The main components of the wood products value chain are broken down into 4 areas: forestry (selecting, harvesting, sorting and transporting logs); primary breakdown (sawing logs into boards and sorting according to dimension); finishing (drying, planning, grading, trimming, sorting and packaging); and sales and shipping of finished goods. Appendix 2 provides more detail of the operations involved in receiving logs, primary breakdown into boards, and shipping rough production off site for finishing.

Since GFP sells homogeneous commodity products, the value of information bundled into their products is proportionally small. However, valuable information could be added to their products and might include quality assurances, timber source, and bar-coded stamps which integrate with customer inventory systems. Valued information could also be incorporated into supporting services. For instance, customers might value tightly linked inter-organizational IT systems which build efficient relationships and lower transaction costs.

The costs associated with each general area of the value chain have been roughly estimated in Appendix 5 to relate various value chain activities as a percentage of total product value. Overhead costs have been allocated based on the total number of board feet produced in a specific time period. It can be seen that log costs and outsourced planing are responsible for the majority of costs along the value chain. This breakdown is helpful to identify where IT systems may have the largest impact on either increasing value or reducing costs. Since a large percentage of expenses are tied to log costs and outsourced planing, there may be opportunities to apply IT to more efficiently and effectively manage these activities. As a result, costs would be driven down through increased coordination of value chain activities and value would be increased through product differentiation.

SWOT Analysis

A SWOT analysis was used to summarize the internal strengths and weaknesses of GFP with external market opportunities and threats which form the basis upon which GFP strategies are based. ITs need to support the strategies resulting from the SWOT matrix in Table 4.

	Strengths Lean, mean structure Flexible, agile, willing to change Ability to source fiber Low capital investment Innovative use of old technology Ideas for creative products Expert managers in their fields Non-unionized, relaxed environ.	Weaknesses Lack structure and support Weak financial controls Limited resources No kiln or planer capacity Mgmt has many tasks & no time Old equipment maxed out
Opportunities Current strong market Partnership with broker Partnership with $ saver (planer) Forestry contractor/partner with financial support Availability of fiber (for now) Home reno fad (sq edge lumber)	Strategies combining Strengths & Opportunities Short term – use low cost equip. & fiber for square edge lumber program ideal for home centers. Ride down experience curve in analyzing wood fiber, processing, marketable products. (integrated) Incentives geared to non-monetary rewards, atmosphere, challenge	Strategies combining weaknesses & Opportunities Formalize partnerships Tighten bonds with MOF, planer, broker, Canfor Sub. process & IT for manpower
Threats Market may crash (cyclical) Availability of fiber (5-10 years) Effect of pine beetle Competitors with deep pockets & highly optimized mills Canfor single buyer of chips US trade barriers Chinese & Russian fiber supply Worker migration to competition Substitute products	Strategies combining Strengths & Threats Apply innovative culture, operating expertise, management processes, existing distribution networks, industry connections to develop high value niche products with slightly modified equipment & less available & low quality fiber. Non-commodity products bypass trade regulations	Strategies combining Weaknesses & Threats Formalize partnerships Tighten bonds with MOF, planer, broker, Canfor Sub. process & IT for manpower

Table 4 - Gateway SWOT Analysis

Gateway Forest Products' Strategy

Through the use of various strategic frameworks the stakeholders involved in the technology roadmapping process have become familiar with the major environmental conditions, internal strengths and weaknesses, and value chain activities related to GFP's strategy.

In the short term, 2 to 5 years, GFP will focus on efficiency improvements in the commodity dimensional lumber industry to achieve a state of cost parity with their major competitors. This is possible during a period characterized by a relatively strong lumber market, cheap fiber, and readily available, low cost, used manufacturing equipment that large competitors are liquidating to make room for high cost, cutting-edge, optimized manufacturing technologies.

During a period where there is a bit of slack available, GFP can use the opportunity to build the manufacturing experience, knowledge and processes required to survive a more difficult future environment. Specifically, GFP can focus on producing high grade square edge lumber which is in demand while developing the processes required for maximizing value and reducing cost along the entire value chain. It is especially important for GFP to manage log and finishing costs since they make up such a large proportion of total costs.

Formalizing partnerships with forestry contractors, chip buyers, and companies with planing capacity will reduce GFP's risk of not being fully integrated (lacking control over the value chain) and will reduce capital requirements. Free resources can then be used for implementing creative management and IT processes required to support the coordination of new innovative and diversified value chain activities in the future.

Workshop 2 – Current Use Of Information Technology

The second workshop with GFP management focused on assessing the current use of IT and the level of employee IT sophistication. The resulting information was related to industry standards and best practices to identify opportunities for technology accelerated performance improvements. The information links between stakeholders related to GFP are provided in Appendix 4 and the main information flows identified through the assessment of the current IT situation are captured in Appendix 6.

Use Of Information Technology At Gateway Forest Products

GFP uses the Internet, email, the world wide web (WWW) and other ITs to research sources of raw logs on the open market and from the Canadian government. Further, GFP uses a MOF web application to report how much timber is harvested so that stumpage can be charged. Each logging truck's weight is measured and recorded at the scale on a proprietary IT system that interfaces with the MOF's web application. The system also randomly samples trucks using a wireless handheld computer to record the statistical average size and quality of inbound logs. Since log costs make up a large portion of total cost of goods sold, the systems used to manage log supply are becoming increasingly important, especially since the average size and quality of BC timber is diminishing.

Two GFP employees concentrate on finding the best suited logs for the sawmill and coordinate contractors to harvest and transport logs into the sawmill. GFP uses the MOF website, computer spreadsheets and a software package called Simply Accounting to estimate, track, and manage the supply, inventory and overall cost of timber. Unfortunately, the process used to update and analyze log inventory is complex, time consuming and erroneous because of the manual calculation required and number of systems involved.

Some of the most beneficial information is generated from productivity testing, where the cost of all inputs are related to the value of lumber sales. Value is optimized by varying the types of logs harvested, methods of processing logs, and logistics involved in shipping products to customers. It is essential that direct log costs (sourcing, harvesting, transporting, scaling, sorting), conversion costs (debarking, primary breakdown, edging, sorting, trimming, drying, planing) and shipping costs (wrapping, transportation, invoicing, customer relations) are compared to the total value of end products. Dividing total outputs (value of lumber) by total inputs (log, conversion, shipping, and overhead costs) must result in a number greater than 1, otherwise GFP loses money. Productivity information is currently tracked, processed and analyzed through the use of spreadsheets and Simply Accounting. Incorporating direct and indirect financial costs into productivity models is manually intensive, time consuming and error prone.

Logs are moved from inventory into primary processing in the sawmill. Bark is stripped from each log at the debarker. No information is tracked directly at this machine center, although lumber and chip quality is related closely to how well each log is debarked. If too much bark contaminates chips sold to Canfor the value of pulp and paper products is reduced, and GFP is charged fines or is prohibited from selling chips.

Logs then move through the optimized canter, which chips logs on four sides into cants and saws up to 4 side-boards with wane (rounded edge) on one side. Cants are further sawn into dimensional lumber in the saw box. The canter and saw box are considered the most important machine centers in the mill because they determine what products are ultimately produced. The use of IT is critical to optimizing canter and saw box value recovery. Canter cutting parameters are periodically adjusted based on current and future customer orders, market prices, logs harvested and the sawmill's lumber recovery factor (LRF). LRF is defined as the number of board feet produced per cubic meter of input log fiber as measured by MOF standards. A board foot, or foot board measure (fbm), is defined as a volume of solid wood equal to 1"x12"x12". Detailed information is collected on the number, dimension and volume of logs sawn and rough lumber produced. However, this information is only available in printed report form and difficult to combine with other reporting and analysis information systems. Therefore, the use of this information is limited to running manual simulations with computer spreadsheets and feeding the results back as canter parameters for further optimization. Lumber output information from the canter is not used for calculating bottom-line results because more accurate production information exists at the sorter and stacker. However, log input volume information captured at the canter is used to determine the cost of logs related to lumber output from the sorter in a spreadsheet.

Side boards are routed through an optimized edger, which scans each piece and decides how to process them into more valuable lumber. Key information is available in printed reports and includes the number, volume and dimensions of pieces processed. These reports are seldom utilized because they need to be manually combined with information from other systems in a spreadsheet to be meaningful. The information is also less meaningful because optimized edger parameters are rarely adjusted.

Dimensional lumber from side-boards and cants pass through a grading station and are sorted, stacked, and inventoried according to dimension. Low quality boards are either re-routed to the edger for upgrading or are sent to the chipper. The number of re-edged and rejected boards is an indicator of canter and edger performance. However, there is no IT available to record and report this information. Manual tallies on paper are monotonous, costly, and error prone.

As boards pass through the sorter, they are individually scanned and sorted into bins according to their dimension. The sorter's programmable logic controller has the potential to record and report this detailed production information, but the capability has only been partially implemented. This information is critical for managing and relating rough lumber inventory to log volume input and planed lumber output so that one can determine the overall efficiency of the manufacturing process. Since rough sawn lumber is planed offsite, it is imperative to manage these outsourced relationships closely to ensure that companies planing the rough lumber are acting in the best interests of GFP.

Rough lumber production is currently estimated by manually recording the number of stacked lifts on paper and is re-entered into a spreadsheet. However, stacks of rough lumber contain boards of random length and there is no way to feasibly measure the output volume precisely. Thus, it is estimated using a calculated average volume per sorted lift. This is sub-optimal because the recorded production and inventory levels can deviate from actual levels and incorrectly represent productivity.

Sorted lifts of rough lumber are shipped to an offsite company for drying, planing, wrapping and transportation to customers. These offsite companies provide GFP with estimates of rough lumber inventories on their premises using similar manually estimated tallies on spreadsheets. These estimates are likely accurate in the long-term due to averaging of inventory deviations, but fail to provide meaningful accuracy for short term decisions. For instance, because rough lumber inventories can be inaccurate in the short term, it is difficult coordinate planer production with scheduled customer orders. However, these companies do provide accurate information on planer efficiency and finished package inventory in a spreadsheet which is given to GFP daily via email. The cost of planing rough lumber is based on this accurate production information multiplied by a cost per unit of output. Aggregate costs are entered into Simply Accounting for record and payment.

GFP relates their rough lumber production schedule with those of outsourced planers to determine what they can sell through a third party lumber broker. The use of spreadsheets is prevalent for keeping and reporting inventory levels while actual sales and shipments are tracked in Simply Accounting.

Simply Accounting is also used for tracking and reporting other financial information including: capital expenditures; depreciation; wages, salaries, employee benefits and vacations; miscellaneous expenses and purchases, sales and adjustments. Some financial information can be directly assigned to manufacturing costs for reporting purposes while non-direct overhead expenses should be indirectly allocated to major cost centers. This is not done on a frequent basis, and GFP can not readily or accurately assess productivity and financial condition for making important management decisions. This may be due to lack of time, training, human resources or software functionality. It would be beneficial to develop processes where direct and indirect costs are allocated to finished goods for making management decisions.

GFP's bookkeeper is the primary user of Simply Accounting and is trained to perform simply data entry tasks. Therefore, the use of financial data is restricted to simple record-keeping activities including recording employee payroll, accounts receivable, accounts payable, capital purchases and depreciation. Information is recorded into high-level accounts which limits the type of reporting and analysis that is possible. It would be beneficial to leverage the knowledge of a certified accountant with industry experience to suggest methods of setting up appropriate accounts and processes to support management reports and periodic financial statements for meaningful decision making. Accurate and detailed financial information is critical to implementing activity based costing systems which relates costs to specific and manageable activities.

The use of IT at GFP is influenced by the moderate level of IT sophistication displayed by administrative employees at GFP. The lack of timely financial information can be partially attributed to a basic level of IT sophistication at GFP. Although GFP recently purchased computers for their few administrative staff and purchased a high speed Internet connection, the use of IT is limited to desktop applications such as web-based research, email, word processing, and computer spreadsheets. These main uses of IT relate to a basic (moderately low) level of IT sophistication according to Chesher *et al.* (2000). The next logical progression is to move into a substantial level of IT sophistication characterized by the ability to use an interconnected network of IT systems to achieve business goals. In order to implement the IT roadmap GFP will have to move into a higher level of IT sophistication.

Information Technology Gap Analysis

Information collected on current IT use is compared to industry standards, best practices and expert opinions to form a gap analysis. As per the industry standard, GFP makes good use of the Internet, email, and WWW technologies for researching potential suppliers of goods and services and for general research. The use of EBay has been valuable in sourcing electrical equipment at a fraction of retail prices. GFP does not have a web site for general information and marketing purposes as per the industry standard.

GFP follows best practice by making use of the MOF web site for reporting harvesting information. This information is used in conjunction with other harvesting information collected in spreadsheets in order to manage their log supply and inventory. Other FPI companies use a purchased ERP system or custom built databases. Further, GFP uses relatively new computer aided manufacturing technologies which utilize information calculated from printed reports, market data and computer spreadsheets. Sawmill productivity, quality control, inventory, outsourced planing capacity, sales and marketing activities are managed through the use of printed reports, spreadsheets and Simply Accounting. Other companies in the industry use an ERP system, a custom database, or small specific software packages (SiCam or LSize) for managing productivity and quality.

GFP's management information systems (printed production reports, spreadsheets and Simply Accounting) are manually intensive, inaccurate, and lack the timeliness required to make short term decisions. Major competitors in the forest industry are implementing large ERP, SCM, and inter-organizational systems which tightly link suppliers, manufacturing operations, and customers with streamlined, real-time, and accurate information.

This is not necessarily a problem as long as the cost of extra manual effort, slightly erroneous data, and delayed business decisions is less than the cost of implementing a large integrated information system. This is probably the case, since the cost of implementing ERP systems can range from $100,000 to over $1 million. Further, GFP does not have enough suppliers and customers to justify a large commercial IOS. These suppliers and customers can be more efficiently tracked with simple databases or spreadsheets.

GFP differs from the rest of the FPI in terms of the average level of IT sophistication of administrative staff. GFP administration has displayed a basic level of sophistication, where similar administrative employees within the FPI show higher levels of IT sophistication. This is especially true of the large players, which use highly integrated and networked IT systems across geographically dispersed divisions to achieve business goals. Chesher *et al.* (2000) relates these characteristics to a high level of IT sophistication.

Workshop 3 – Business Drivers

The third workshop focused on organizing findings from the first two workshops into specific performance dimensions, business drivers, CSFs, and priorities which relate directly to current and future environmental conditions, and GFP's strategies for dealing with those conditions.

The CSFs that GFP uses to understand profitability can all be related to a single measure – margin per 1000 board feet (Mfbm) of production. All costs can be directly assigned or indirectly allocated to each Mfbm of production. These total costs per Mfbm are taken from the average market value of lumber per Mfbm to determine margin per Mfbm. The costs per Mfbm are assigned or allocated to raw materials, work-in-progress, and finished goods through the entire value chain. As per Appendix 5, the cost of logs and planing have the most impact on total costs per Mfbm followed by labour and manufacturing overhead. The environmental factors and market forces have an influence on the value chain, and resultantly the CSFs. GFP strategies and potential IT implementations must positively affect these CSFs.

The most important environmental challenges outlined in the first workshop include the diminishing local log supply relative to other countries, pressure for the MOF to increase stumpage rates, potential for commodity lumber prices to fall, uncertainty with respect to US trade barriers, weakening US dollar, lack of skilled workers, and increasing availability of alternative substitute products. On the positive side, the trend towards do-it-yourself building and renovation supports demand for high quality wood products. Further, technological advances in equipment and IT are allowing increased productivity. Technology adoption is generally slow in the FPI which allow GFP to catch up while there are still margins available. All of these conditions will influence the CSFs that determine GFP profitability into the future.

The most negatively influential market forces include high timber supplier power, high lumber and chip buyer power, lack of skilled workers, moderate threat of substitute products, and high degree of rivalry due to local industry concentration. Some market forces positively influence GFP business. These include close working relationships with forestry contractors and wood products brokers, moderate barriers to entry, and the current ability to collaborate with large competitors to gain knowledge.

Table 5 relates environmental conditions, market forces, and business strategies with CSFs (related to the value chain) to form the highest 2 levels of the technology roadmap (see Appendix 7). The aggregate CSFs including $log/Mfbm, $labour/Mfbm, $planing/Mfbm, $OH/Mfbm, and $price/Mfbm are included on the graphical roadmap.

Factor	CSF	Impact
MOF increasing stumpage	$log/Mfbm	Negative
Diminishing log supply	$log/Mfbm	Negative
Lumber prices	$price/Mfbm	Negative
US trade barriers	$price/Mfbm	Negative
Weakening US dollar	$price/Mfbm	Negative
Shortage of skilled workers	$labour/Mfbm	Negative
Substitute products	$price/Mfbm	Negative
Do-it-yourself trend	$price/Mfbm	Positive
Equipment & IT advances, slow industry adoption	$log, $price/Mfbm	Positive
Timber supplier power	$log/Mfbm	Negative
Lumber & chip buyer power	$price/Mfbm	Negative
High degree of rivalry	$log, $price/Mfbm	Negative
Close relationships with contractors & broker	$log, $price/Mfbm	Positive
High barriers to entry	$log, $price/Mfbm	Positive
Possible collaboration	$log,$labour,$OH, $planing / Mfbm	Positive

Table 5 - Business Drivers

Workshop 4 – Products and Capabilities

The fourth workshop focused on determining which capabilities could positively affect the CSFs in the second highest level of the IT roadmap. Table 6 shows which capabilities could positively influence the CSFs identified in the previous workshop. The capabilities form the bridging layer of the technology roadmap between the CSF's and IT resources required to support the capabilities (see Appendix 7).

In order to reduce the $log/Mfbm, GFP needs to increase the utilization of existing and future sources of logs. This can be accomplished by focusing on developing high value square edge and niche wood products. This is consistent with GFP's strategy identified in the first workshop and recommendations of Hetekami *et al.* (2005) and Craghead and Laforge (2003). Labour and overhead costs per Mfbm must also be kept as low as possible. This relates directly to the capability to maintain a low number of administrative employees by implementing processes to streamline administrative work. Also, by maximizing manufacturing productivity and throughput, one effectively reduces the $labor/Mfbm and $OH/Mfbm by increasing the common denominators, while keeping the labour and overhead costs constant. One way to impact the costs of drying, planing, wrapping, and shipping lumber is to increase control of outsourced planing operations. This can be accomplished by accurately recording information on internal sawmill and external planing operations, making modifications to sawmill operations (such as reducing rough lumber target sizes), suggesting changes to planing operations (like speeding up planer operations), and controlling for quality, trim loss, and end product value. Finally, the $price/Mfbm (the price received for products) can be affected by developing higher value square edge and niche wood products and exerting limited price pressure through GFP's wood products broker.

CSF Impact	Capabilities
$log/Mfbm	Increased existing and future fiber utilization Develop high value square edge & niche products
$labour/Mfbm $OH/Mfbm	Processes to support few admin employees Increase manufacturing productivity & throughput
$planing/Mfbm	Control drying, planning, wrapping, and shipping.
$price/Mfbm	Develop high value square edge & niche products Increased control through broker

Table 6 - Products and Capabilities

Workshop 5 – Information Technology Resources

The fifth workshop identified the IT resources required to support the capabilities outlined in the previous workshop and relied on industry research on best practices and expert opinions related to current and future IT use in the FPI. Potential IT implementations which could cost more than $20,000 were excluded in the short term (1 year) due to GFP budgetary constraints. Specifically, large ERP and MOM implementations are not possible in the current year. The key uses of IT are related to the capabilities they must support as shown in Table 7. These IT resources make up the lowest level of the technology roadmap in Appendix 7.

Products & Capabilities	IT Resources (Requirements)
Increased existing & future fiber utilization Develop high value sq edge & niche products Increase manufacturing productivity & throughput	Log management (selection, sorting, inventory) SCM - value chain optimization/management Streamlined financial control & reporting
Control drying, planning, wrapping, and shipping. Increased control through broker	IOS (rough & finished lumber inventory) IOS (lumber & chip purchases) CRM
Processes to support few admin employees	Streamlined financial control & reporting Automate data (inventory, production, finance) SCM - value chain optimization/management
Supporting IT Capabilities	IT Resources
Ability to maximize IT use	Increased employee IT sophistication
Central data storage & backup	Central server, data storage & backup
Transfer data electronically	Internal & external computer network

Table 7 - IT Resources (Requirements)

GFP uses various ITs to select, sort and keep track of their log supply. GFP needs a program for systematically recording the costs and value of log inventory as logs are brought on site. This will help facilitate accurate records which can be used for financial reporting, breakdown optimization, and integrated value chain management, which in turn should give rise to the ability to experiment with new fiber sources, increase existing fiber utilization, develop niche and square edge products, and increase manufacturing productivity and throughput. These needs are related to recommendations by industry experts such as Hetekami *et al.* (2005) and Craghead and Laforge (2003) to implement SCM systems to mange value and costs along the entire value chain.

It is possible to strengthen external relationships by implementing IOS systems for managing rough lumber and finished goods inventory as well for managing lumber and chip purchases. These systems lower transaction costs and improve transaction quality for all parties involved (Vlosky *et al.*, 1994). They also improve GFPs relative power over business partners and increase customer switching costs. The data from IOS systems can be augmented with CRM data (addresses, preferences, unique notes) to help support the needs of GFP customers.

Streamlining financial controls and reporting refers to the ability to readily and accurately enter and report financial information in an accounting system that is closely tied to manufacturing operations management and inventory systems. This would allow GFP management to obtain daily, weekly and monthly information on financial condition, operational efficiency, and profitability. This information would facilitate decision making with regard to financing, capital purchases, product development, and equipment modifications. Implementing procedures and automating data entry from production systems would help to ensure that financial information is always up to date. For instance, allocation of costs to sorted log inventory, rough lumber inventory, and finished goods can be automatically entered at the scale, sorter and planer and quickly verified by the employees in their respective areas.

As suggested by FPI industry experts such as Hetekami *et al.* (2005), Craghead and Laforge (2003), and Poku (2003), GFP needs to optimize value recovery from wood fiber throughout the value chain while simultaneously reducing manufacturing and overhead costs per Mfbm of lumber produced. A module is required to provide management consistent processes for profitability testing of new wood fiber, products, equipment and cost structure changes, and reducing costly manual data entry and errors. This module would facilitate the ability to simulate the value of sawmill production given specified sets of timber resources, sawmill capabilities, and assumptions of market prices.

Implementing some of these IT systems would require an investment in IT infrastructure and human resource training. GFP should initially only implement a single networked database system to facilitate learning how to record, report, and verify information. The infrastructure required for implementing centralized data storage and reporting include an internal computer network, an external connection to the Internet, a computer at each management desk, and a central server with regularly scheduled backups.

Workshop 6 – Technology Roadmap

The last workshop was focused on mapping the business drivers, CSFs, capabilities required to positively affect the CSFs, and the IT resources that give rise to those capabilities on a time line. The graphical representation of the IT roadmap can be found in Appendix 7.

Since GFP currently has a basic understanding of IT (Chesher *et al.*, 2000), it is recommended that the main users of information initially design the processes to obtain and process information which is critical to managing the business. Specifically, it is important to be able to understand GFPs financial condition at the end of any one day, week, or month. This means that financial information must be collected and processed daily. Since all CSFs are related per Mfbm of lumber produced, all associated costs should be directly assigned or indirectly allocated to various stages of inventory so that a comparison can be made between total cost of goods sold and customer purchase price. In the short term, spreadsheets and Simply Accounting should continue to be used for storing and reporting financial information because the employees are familiar with those tools. The focus should be to develop a detailed understanding of information flows and not on using specific software packages because an iteration of the roadmap and further detailed requirements analysis may show that other software packages are more effective. This initial implementation stage should assist GFP's human resources to develop a higher level of IT sophistication (Chesher *et al.*, 2000) and to more easily adopt new ITs (Poku 2003, 2004, Vlosky, 2004, and Craghead and Laforge, 2003).

This will require consulting a certified managerial accountant with experience in the FPI to assist in setting up appropriate account codes, financial period closing procedures, and financial and managerial reports. GFP needs to consider training management on the use accounting software, general IT reporting techniques, and how to use various types of management information systems. User training is critical in implementing IT systems, and cannot be left out of any IT project budget. Further, one must ensure that employees understand that their jobs are secure even though new IT systems will be implemented.

GFP will need to invest in IT infrastructure before implementing the IT systems as outlined in the previous workshop. GFP should leverage its existing investment in a high speed Internet connection while improving its local area network to support a centralized server which provides IT applications, data storage and data backup.

The module for managing log supply should be implemented first, because log costs make up the majority of total product costs and should have the most impact on operations. This module must take into account different sorts of logs (based on species, grade, dimension and stumpage rate) and allocate costs based on those sorts. These sorts must map one-to-one with account codes set up in an accounting system for financial and management reporting purposes. The module should interface with the MOF online harvesting database for ease of data input, reporting and reconciling stumpage costs. The output from this module should be sent to an accounting system to update the appropriate accounts, and to the sawmill management module described later in order to update the average cost of wood fiber through the rest of the value chain.

The next IT resources identified in the previous workshop were meant to optimize all value chain activities on an overall basis. This type of SCM IT resource is identified by Hetekami *et al.* (2005), Craghead and Laforge (2003), and Poku (2003) to have high potential return on investment. Optimizing value chain activities on an overall basis requires IT resources for managing the remaining three major segments of the wood products value chain –primary breakdown, rough lumber finishing, and marketing. Three corresponding IT modules are required for managing sawmill, planer, and marketing information.

The sawmill management module should receive data from the log management module. Further, the sawmill production management module should receive manually entered production data or automatic data entry directly from the process controllers at the end of each shift. Log, labour, and overhead costs should be assigned to specific rough lumber accounts (determined by product types) in an accounting system in order to accurately track costs through the value chain.

The planer management module should manage transfers of rough lumber to offsite planers. This involves making offsetting entries both within the module and in an accounting system. The offsite planer provides GFP with daily planer production reports which relate rough lumber input to finished product output. The rough lumber input is deducted from within the planer module and automatically updated in an accounting system. The cost of planing is added to the finished lumber output and entered into the production management module, which automatically updates an accounting system.

In this manner, costs are tracked throughout the value chain and closely estimate the actual costs associated with finished products. Manufacturing operations can then be managed by minimizing costs allocated to rough lumber in the sawmill, minimizing costs allocated to finished goods at the offsite planer, and maximizing end product value.

The marketing module is responsible for coordinating available and predicted finished goods inventory with customer orders. Customer orders can be placed with this module reserving inventory for shipment. When orders are finalized and shipped, they should automatically be entered into an accounting system, reducing end goods inventory and incrementing revenues.

Once the log, sawmill, planer, and marketing management modules are implemented, or at least specified in detail, the value chain optimization module can be fully specified and implemented. This module would allow GFP to predict profitability with a given set of resources, capabilities, and assumptions. The resources could be a stand of timber, cut logs already in inventory, or rough lumber inventory. The capabilities could be populated by manually entering data or by accessing existing productivity records in the system. The capabilities are essentially sets of empirical functions which emulate production processes which take inventory from one stage in the value chain to another. For instance, standing timber is related to log inventory, log inventory is related to rough lumber and rough lumber is related to finished goods. The assumptions are automatically set to current CSFs such as costs of logs, labor, overhead, planing, and lumber price per Mfbm, and can be manually overridden to test alternative scenarios.

The next IT that GFP should implement is an IOS for automatically reconciling GFP records with offsite planer rough lumber and finished goods inventories. This system would be used at the offsite planer operation. As rough lumber is planed into finished goods, sold, and shipped to customers, the IOS system should automatically provide updates to the sawmill, planer, and marketing systems. These systems should then also automatically update financial information in an accounting system.

GFP may also want to look at implementing simple IT systems for statistical process and quality control (SPC) as in Young *et al.* (2000). This system would not be linked to an accounting system since financial information is difficult to trace back to quality information. Therefore, an SPC system would simply be used for daily operations control and benefits would be indirectly linked through the capabilities to produce high quality wood products.

One of the last modules that GFP may want to pursue is for managing customer relationships. A CRM system can be integrated with the sales and logistics module to track and report details on customer purchases, key contacts and addresses, and preferred shipping and payment methods. These details can help increase the customer value proposition by tailoring products and services to specific client needs as well as improving on time, on quality, and on specification delivery.

Expensive VMI systems would not currently benefit GFP since they are complex and expensive. GFP lacks the volume of customers to justify the large expense. Once the critical ITs and processes are in place and working efficiently, these leading-edge technologies should be reassessed.

In fact, the entire roadmap developed in this project should be reassessed periodically to reflect changing IT sophistication levels, environmental conditions and internal resources. Since the roadmap presented in this paper is the first version produced, it is recommended that the roadmap is validated and fine-tuned at least twice by GFP's operating committee to ensure that it is accurate, relevant, and of high quality (Bray and Garcia, 1997 and Garcia and Bray, 1998).

As suggested by VanHorne *et al.* (2004) GFP can make use of small, inexpensive, and effective BoB software modules for managing timber supply, manufacturing operations, marketing, logistics, and optimization. These smaller systems can be integrated with technologies like EDI, XML and web services. Small local software companies like Terra Cognita and AgileIT can develop specific small software modules that integrate with Simply Accounting to replace spreadsheets and manual calculations at a fraction of the price charged by large software vendors. These modules can also be configured to work with major suppliers' and customers' systems to promote close and efficient working relationships. Small packaged systems can be purchased and similarly integrated although they rarely produce expected results. A relationship with the University of Northern British Columbia for pursuing industrial collaborative research could be mutually beneficial. The high level of expertise at UNBC can be put to practical use at a reasonable cost while promoting the usefulness of academia.

DISCUSSION

Although the FPI has been laggard to adoption IT, industry experts have indicated that various ITs positively affect profitability. Such ITs include supply chain management, production optimization, operations management, automated quality control, vendor managed inventory, customer relationship management, and B2B e-commerce. When these ITs are combined into single seamless solutions, they are called manufacturing operations management or enterprise resource planning. Because log costs make up a large proportion of COGS, and are expected to rise, SCM systems focused on managing log costs are becoming more important. Industry experts further indicate that implementing ITs to manage all cost and value added along the entire value chain could most positively impact profitability. The industry research was discussed in the technology roadmapping workshops instead of including an industry expert.

Initially, the researcher expected to find exciting IT strategies that would dramatically increase the profitability of GFP. Through reading literature related to the strategic management of IT, that excitement quickly gave way to the realistic truth – there is nothing magical about managing IT resources. They should be managed in the same way as other business resources by using common strategic frameworks and methodologies. In order to develop any strategic plan, one must analyze the external environmental conditions, the capabilities required to capitalize on those conditions, and the internal resources required to support those capabilities. This classic strategic planning forms the foundation of technology roadmapping.

Porter (1980, 1985), Porter and Millar (1985), Bakos (1986), Clarke (1994), and Devaraj and Ranjiv (2002) discuss competitive IT strategy and place emphasis on assessing external environmental conditions in formulating business strategy. They reference Porter's five forces model, Porter's generic competitive strategies, SWOT analysis, and PEST analysis to determine how IT can support competitive business strategy. These tools are used directly to determine the top layer elements (market forces and business drivers) of an IT roadmap. Capabilities that can influence those top-level constructs form the middle-layer of the IT roadmap. IT Resources that support the capabilities in the middle-layer are sought to form the lowest level of the IT roadmap. In this manner, the IT roadmapping process is market-driven and forms a top-down competitive approach.

Grant (1991), Mata *et al.* (1995), and Powell and Dent-Micallef (1997) discuss resource-based IT strategies and place emphasis on assessing how durable, opaque, inimitable, and non-replicatable internal resources can support capabilities that can be sources of competitive advantage. They reference SWOT analysis, value chain analysis, and various other frameworks to define how IT resources can support unique and valuable capabilities. IT resources form the lowest level of IT roadmaps and the capabilities they give rise to form the middle level. Strategies are selected which best exploit the unique and valuable resources and capabilities relative to external opportunities. These external opportunities form the highest level of the IT roadmap. Therefore, the resource-based view is related to a bottom-up IT roadmapping process.

Ideally, the IT roadmapping process should combine elements from both the external competitive view and the internal resource-based view. This means the process should be both top-down and market-driven as well as bottom-up and resource-driven. Further, the IT roadmapping workshops include classic requirements analysis techniques. Such techniques include open and closed interviews, brainstorming, synthesis of requirements from critical success factors and expert judgements, and future analysis. The IT roadmapping process is similar to implementing an organizational SISP process where the external and internal environments are considered. Since the focus is on collective learning, collaboration, and continuous improvement, these SISP processes may help to develop IT management skills which can lead to sustainable IT-related competitive advantage.

When the technology roadmapping process was initially selected for determining IT requirements for GFP, the application of the process was assumed to be straight forward. In fact, applying the process was quite difficult in practice for a number of reasons.

Firstly, the researcher was unfamiliar with applying the roadmapping process in a practical setting. Therefore, the roadmapping process and purpose was not communicated to workshop participants as clearly as it would be now that the process has been completed once. Further, it was difficult for the facilitator to keep the workshop group focused on the right tasks. This was especially problematic because only two to four hours had been allotted to each of the six workshops. More time should have been allotted for the first implementation of an IT roadmapping process.

Secondly, too many strategic frameworks were selected for analyzing GFP's environmental conditions and competitive strategies. Porter's five forces model did not fit well into the IT roadmapping process. This is likely because the framework was used for analyzing company-level market forces instead of industry-level market forces (which the framework was designed for). Further, there was a large amount of overlap between Porter's five forces analysis and PEST analysis. Therefore, it is recommended that only one of the two analysis be used in the IT roadmapping process. The value chain and SWOT analysis were much simpler to implement because the workshop participants were already familiar with them.

Lastly, it was difficult for the workshop participants to map (top-down, market-driven) the environmental conditions to CSFs, CSFs to capabilities, and capabilities to IT resources. It was also difficult to try to map (bottom-up, resource-driven) gaps in IT resources to capabilities, capabilities to CSFs, and CSFs to environmental conditions.

Both approaches were made complex by adding the time dimension. Given the time constraints, the workshop participants were unable to predict changes in environmental conditions, CSFs or schedule implementation of IT resources with much accuracy. The various elements of the technology roadmap were planned in an appropriate sequence. However, the schedule of those elements is somewhat arbitrary. The roadmap should be refined to more accurately predict changes in CSFs and schedule roadmap elements. Once the quality of the roadmap is improved through future iterations, it would be possible to estimate benefits of implementing the IT roadmap. The benefits could be estimated by (\$price/Mfbm - \$log/Mfbm - \$labour/Mfbm - \$OH/Mfbm - \$plane/Mfbm) x Mfbm. If the benefits exceed the cost of implementing the IT roadmap, then implementing the IT roadmap would result in a positive return on IT investment.

The strategic IT literature outlined various ways that IT can support business strategy and help to sustain competitive parity or to create competitive advantage. Firstly, IT can reduce transaction costs along communication boundaries and enable efficient processes. The IT modules recommended through the IT roadmapping process should enable efficient processes and reduce transaction costs between GFP forestry and sawmill operations, offsite planers, and customers. The reduction of transaction costs through IT process improvements is only expected to sustain competitive parity.

Secondly, IT can reduce manufacturing costs through process optimizations and increase product value through product and service differentiation. The log, sawmill, planer, and value chain optimization modules should assist GFP management to optimize manufacturing operations and improve manufacturing efficiencies (operations per unit of time). Further, the integration of these modules supports GFP's differentiation strategy by allowing management to easily experiment with new fiber sources and products to test actual and potential profitability along the entire value chain. As identified by strategists like Grant (1991), Mata *et al.* (1995) and Powell and Dent-Micallef (1997), the tightly integrated IT, management, and business resources is one of the few ways that IT can lead to competitive advantage. It is the tight and unique combination of IT, with GFP management processes, and creativity that could lead to competitive advantage, not the IT itself. The recommended SPC module will also help optimize manufacturing optimizations, reduce costs, and increase finished product value.

Thirdly, IT can strengthen supplier-buyer relationships. The planer IOS, CRM and customer IOS modules recommended in the later stages of the IT roadmap should address the potential for creating these valuable IT-enabled intangibles which could lead to competitive advantage.

Finally, the IT roadmapping process was just as valuable, or more valuable, than the end product of the process. Anecdotal evidence suggests that strategic plans are rarely accurate and cannot be followed verbatim. Such is the case with IT roadmaps. This is why research such as Bray and Garcia (1997), Garcia and Bray (1998), Phaal *et al.* (2000, 2001a, 2001b), and Knol and Stroeken (2001) call for continuous validation and renewal of IT roadmaps. The IT roadmap developed in this paper needs to be re-evaluated when external environmental conditions or internal resources change or after a period of six to twelve months. It is the very act of strategic planning that builds the difficult to imitate tacit knowledge, management processes, and IT-enabled intangibles that can lead to competitive advantage.

CONCLUSION

Through a review of literature on use of IT in the FPI, various ITs were identified which could potentially benefit GFP. A methodology for systematically identifying IT needs was necessary to select only the most strategically important IT requirements given GFP's current state. The technology roadmapping process was selected for soliciting and developing high level information requirements of GFP.

The technology roadmapping process was beneficial in defining the environmental context, business drivers, strategies, and capabilities required to support the CSFs fundamental to GFP profitability. GFP's IT needs were logically deduced from an understanding of what capabilities were required to support the CSFs. An understanding of which ITs were available, considered best practice, and predicted by industry experts to have the most impact on forest products operations into the future supported the technology roadmapping process.

It is understood that the recommendations to GFP are high level and void of the necessary details required to implement custom solutions or to select specific pre-built software packages. The intent of this project was to assist GFP in defining their information requirements which are integral to supporting their business strategies. The recommendations outlined in this paper form the objectives for smaller, focused and applied implementation projects which should be undertaken in the future. Further work is required to identify and document the technical software requirement specifications (SRS) of each module. The SRS can then be incorporated in a request for proposal for potential vendors or given to a software development company for custom implementation.

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Appendix 1 - Technology Roadmap Template (Commonwealth of Australia, 2001)

1. *Introduction and Background*

- Mission/vision
- Project goals, objectives and end states
- Scope and boundary conditions of the roadmapping effort
- The current industry: its products, customers, suppliers and manufacturing processes
- Market trends and projections
- Relevant constraint (regulatory, stakeholder, budget, etc.)

2. *Technical needs and capabilities*

- Targeted products
- Functional and performance requirements
- Current science and technology capabilities
- Gaps and barriers
- Development strategy and targets

3. *Technology development strategy*

- Evaluation and prioritization of technologies
- Recommended technologies
- Decision points and schedule
- Budget summary

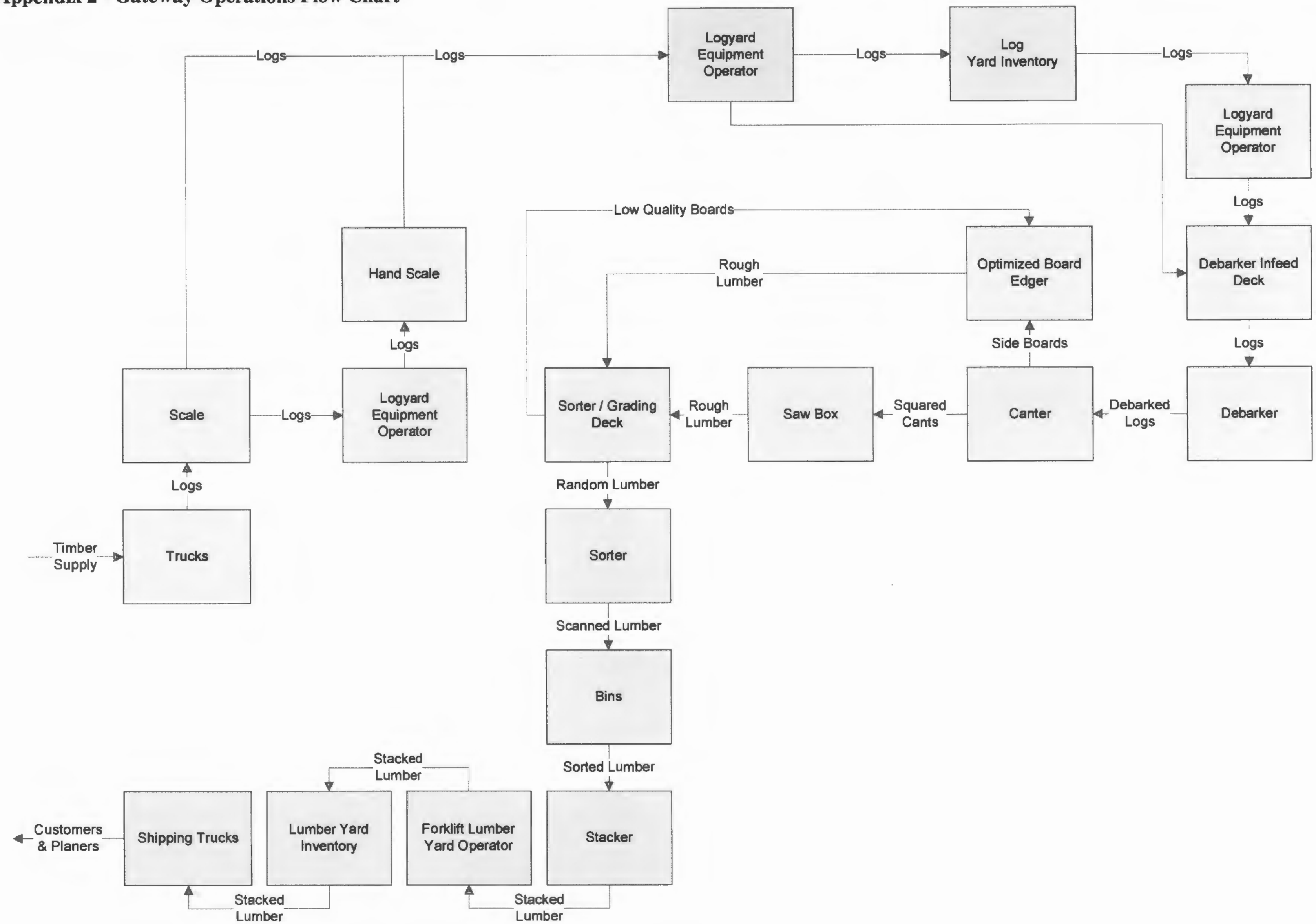
4. *Conclusion*

- Recommendations
- Plan to implement recommendations

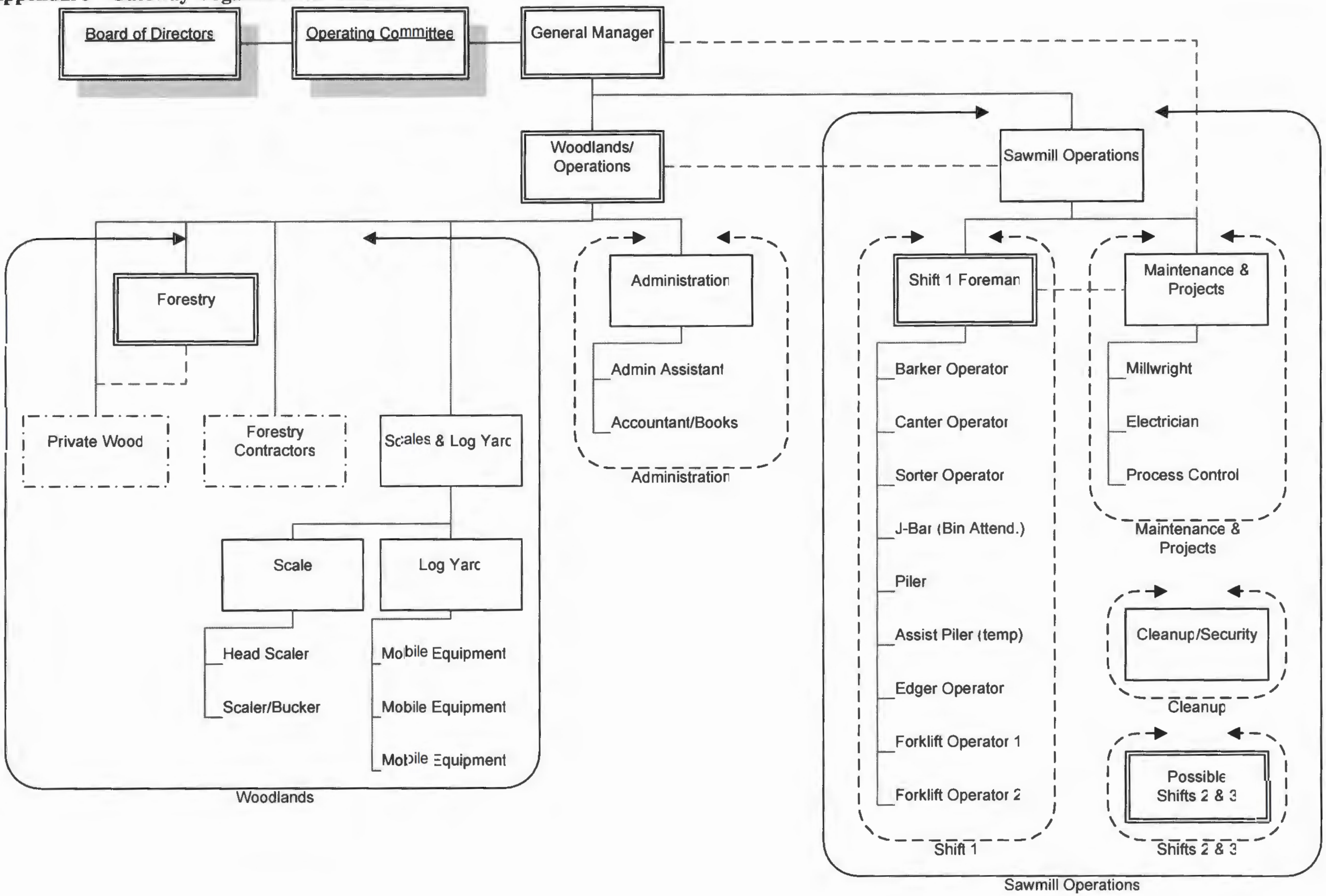
5. *Appendices*

- Roadmapping process
- Participants

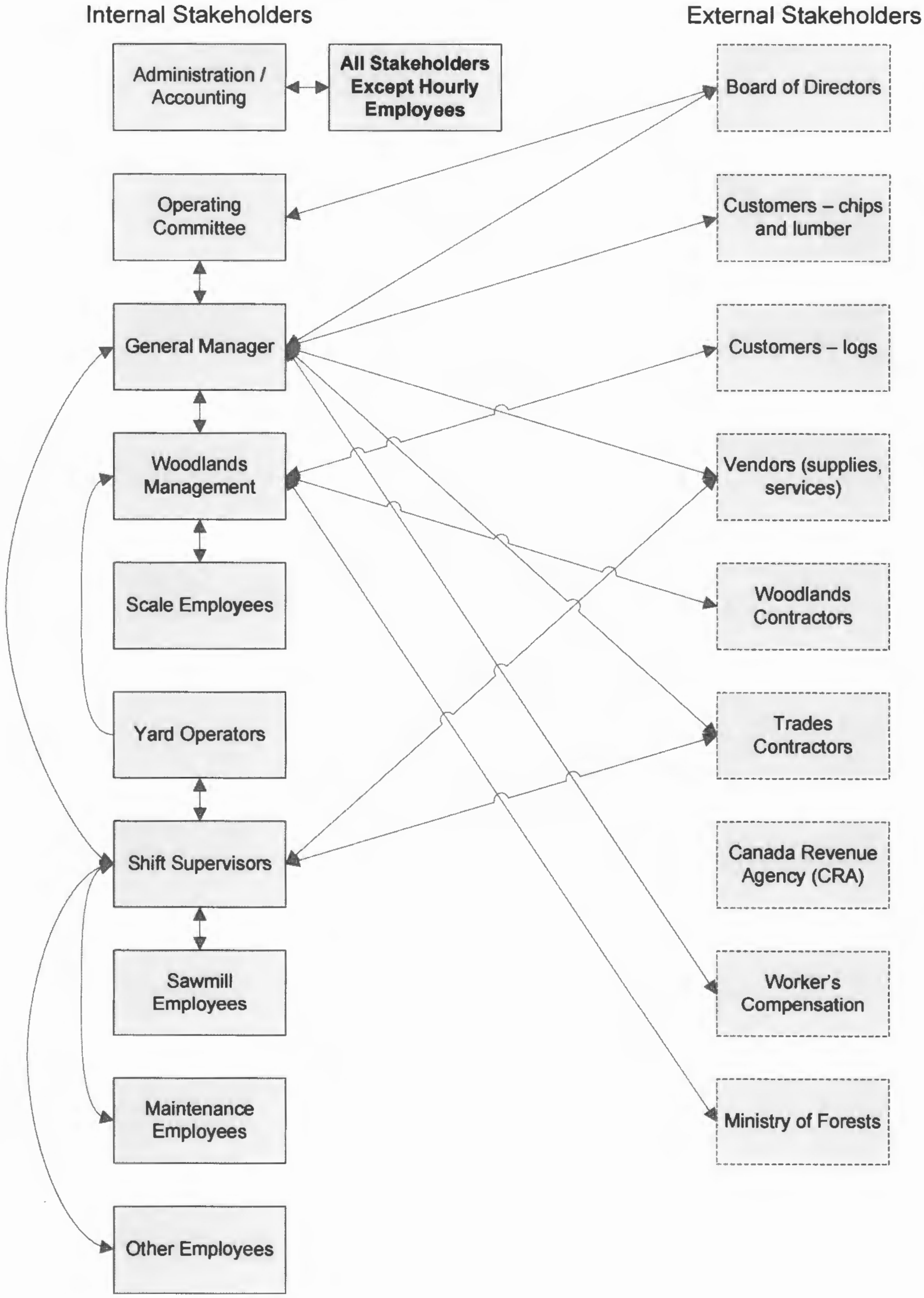
Appendix 2 - Gateway Operations Flow Chart



Appendix 3 - Gateway Organizational Chart



Appendix 4 - Gateway Information Links



Appendix 5 - Gateway Sample Income Statement

Assumtions

Log Volume Into Sawmill (m3)		210000	m3
Average Recovery		250	LRF
Lumber Production Output		52500	Mfbm
Average Lumber Value (after duty & broker commission)	100%	$295	$/Mfbm
Pulp Chips Conversion Factor		0.15	ODT/m3
Pulp Chips		32340	ODT
Pulp Chip Value		$45.00	$/ODT
Log Cost / m3 of input wood fiber		$44	$/m3
Log Cost / Mfbm of lumber output	60%	$176	$/Mfbm
Average Labour Cost	10%	$30	$/Mfbm
Average Planing Cost	20%	$60	$/Mfbm
Average Overhead Cost	10%	$30	$/Mfbm

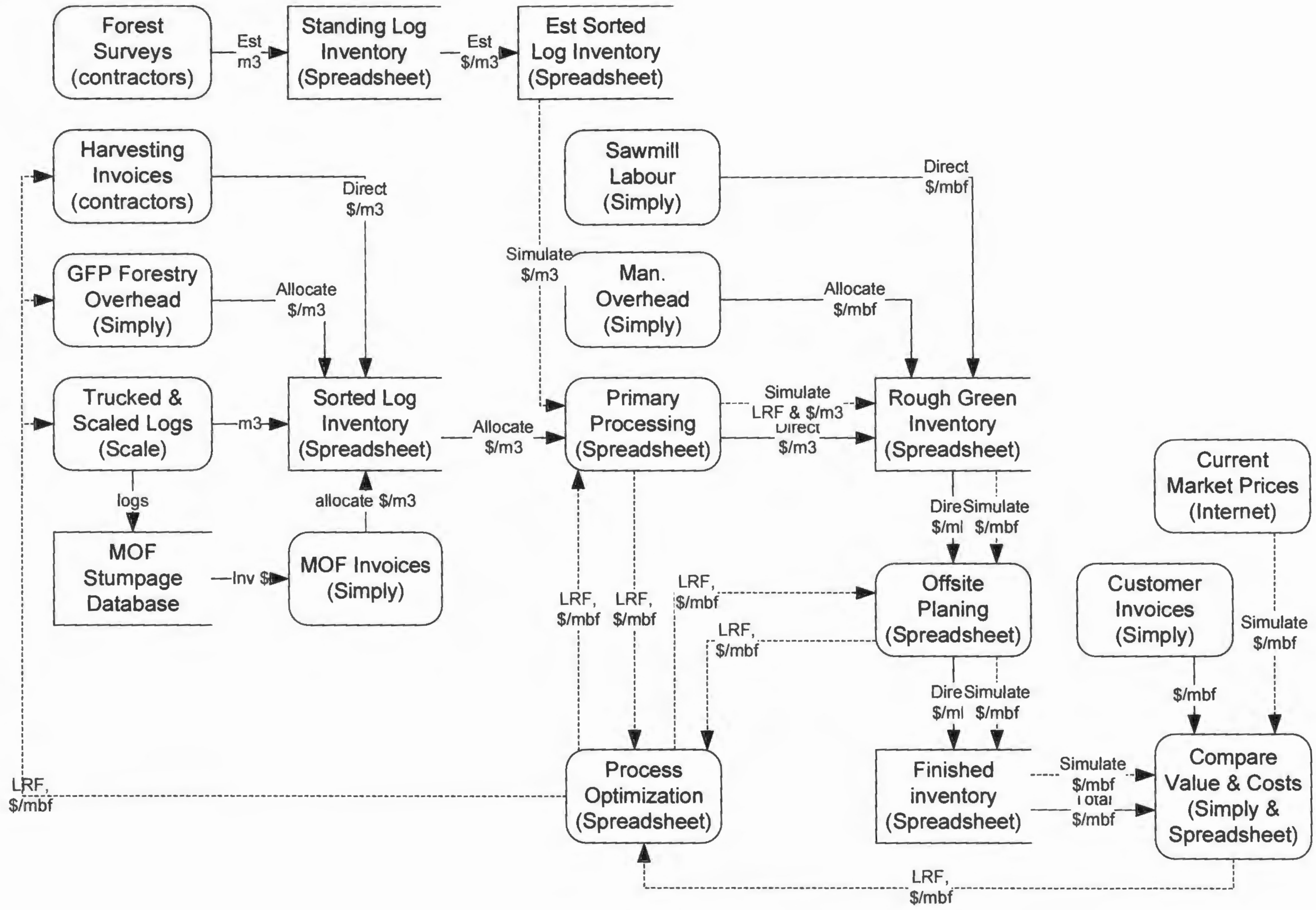
Terminology

LRF = lumber recovery factor = fbm / m3 log volume
fbm = foot board measure = 1"x12"x12"
Mfbm = 1000 fbm
ODT = oven dried tones of chips

Gateway Forest Products
Sample Income Statement (000's)

Revenues			
Lumber Sales		91%	$15,488
Pulp Chip Sales		9%	$1,455
	Total Revenues	100%	$16,943
Expenses			
Log Costs		55%	$9,240
Labour (Sawmill Operations)		9%	$1,575
Planing Costs (Outsourced)		19%	$3,150
Overhead (plant, admin, other)		9%	$1,575
	Total Expenses	92%	$15,540
Operating Income		8%	$1,403

Appendix 6 - Gateway Critical Information Flows



Appendix 7 - Gateway Information Technology Roadmap